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THE METRIC FALLACY

AN INVESTIGATION OF THE CLAIMS MADE FOR THE METRIC SYSTEM AND ESPECIALLY OF THE CLAIM THAT ITS ADOPTION IS NECESSARY IN THE INTEREST OF EXPORT TRADE

BY

FREDERICK A. HALSEY
COMMISSIONER
OF THE
AMERICAN INSTITUTE OF WEIGHTS AND MEASURES

SECOND EDITION
REWRITTEN

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PREFACE

The argument for the adoption of the metric system is based upon the tacit assumption that it is a simple matter for a country to change its weights and measures. Once one has accepted that assumption, it is but a short step to the conclusion that those countries which have made the experiment have succeeded, and then another short step to the conclusion that we can succeed.

The question of the ease or the difficulty of a change in the prevailing system is, clearly, one, not of belief, but of fact. The fathers of the metric system may be excused for holding this belief since they had no experience to guide them, but the world has now a century and a quarter of experience behind it and the time has come to consult the facts. Nearly twenty years of investigation of weights and measures as used in industry and commerce throughout the world and recorded herein have demonstrated that this change of practice is of such difficulty that in no country is it complete while, in most of them, it is a grotesque failure.

The arguments for the adoption of the metric system are, furthermore, based on the tacit assumption that the old units will disappear. The researches recorded in these pages show that what is commonly called the *adoption* of the system is, in reality, nothing more than its *introduction.* The continued use of the old units along with the new can be explained in two ways—that the advantages of the metric system are not found to be such as to justify its adoption or that the difficulties of the change are so great as to make it impossible. Both are correct, but either is fatal to the metric case, for under these conditions the arguments for the adoption of the system are not only destroyed but inverted.

Thus, the argument for a uniform world system disappears in the face of the fact that the adoption of the metric system has in no country brought about a uniform system in domestic affairs. Similarly, the argument for the adoption of the system in order to do away with confusion is inverted by the fact that such "adoption" has only brought about confusion. Again, the argument for economy of time in primary education is nullified and inverted by the fact that the "adoption" of the system has increased and not diminished the work of school children. Still again, the argument that the adoption of the system leads to a saving of time in calculations is negatived and inverted by the fact that the continued use of the old system involves the addition of calculations for conversion between the old and the new, while the argument for fewer and

simpler ratios between units disappears when we consider that a dual system introduces far more and far worse ratios between old and new units than those that now obtain.

The following pages show that for many purposes the change is impossible and that the effect of the so-called adoption of the system has always been the introduction of a dual standard with results the exact opposite of those intended—complexity instead of simplicity, confusion instead of order, diversity instead of uniformity. These results have nowhere been better presented than in The Evolution of Weights and Measures and The Metric System by Professors Hallock & Wade—a book written to promote the adoption of the system and regarded by the metric party as a conclusive showing of the advantages of such adoption. From this book, page 170, we quote as follows:

"We are forced to consider a still more serious difficulty, namely the growth of a dual system due to the increased use of the metric system as permitted by statute. . . . Both systems being legal and the metric measures coming into more widespread use, there would result the perpetual necessity of converting from one to the other in commercial transactions, and, while the nation was waiting for the ultimate survival of the fittest system, or the birth of an ideal scheme, incalculable inconvenience and damage would ensue as has been shown many times in the past."

The case against the adoption of the system is summed up in the statement that the problem does not lie in the introduction of the metric units, but in getting rid of the English units. In none of the so-called metric countries have the old units disappeared. Their experience is a guide—the only guide we have—and, applying it to our own case, the manner in which the argument for the simplification of our weights and measures and of the ratios between units is bound up with the disappearance of the English units and inverted by their comtinued use is best shown by a few examples. With the continued use of the English units such ratios as the following will be added to those we now have:

25.4 millimeters	make 1 inch
6.452 sq. centimeters	make 1 sq. inch
3.281 feet	make 1 meter
10.724 sq. feet	make 1 sq. meter
1.609 kilometers	make 1 mile
2.59 sq. kilometers	make 1 sq. mile
2.205 pounds	make 1 kilogram
28.35 grams	make 1 ounce
2.471 acres	make 1 hectare

For additional examples, without limit, the reader is referred to any engineer's reference book, or to the publications of the Bureau of Standards.

With the argument for the simplification of ratios, there goes its companion for the reduction in the number of units, which falls to the ground if the new units are merely to be added to the old. Clearly, we cannot expect the result of subtraction from the process of addition.

There is no phase or feature of the metric argument that is not destroyed and inverted by the continued use of old units in metric countries, and the confusion and complexities that result therefrom.

The facts here assembled show that the metric system is a will-o'-the-wisp which the nations of theworld are always chasing but never catching, and that it leads nowhere but into a quagmire of confusion and disorder. Shall we take warning from the experience of others, or shall we jump headlong into this bottomless morass? Shall we insist on learning from our own experience, or will we learn from the mistakes of others?

Chapters IX, XVIII, XXIII and XXIV are by my cordial co-worker, in these investigations for nearly twenty years, Mr. Samuel S. Dale.

Attention is especially called to the first three paragraphs of Appendix I.

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THE METRIC FALLACY

CHAPTER I

THE METRIC SYSTEM IN FRANCE

The metric system was adopted in France by a compulsory law of the most drastic character in 1793. That law remained in force for nineteen years, or until 1812 when, under Napoleon who had no faith in the system, the law was repealed and the people were permitted to resume the use of their old measures which soon received the official title the Système Usuelle—a name which, in two words, tells the whole story. Under relaxed laws, the French people immediately reverted to that truly universal system in which twelve inches make a foot, three feet make a yard, and sixteen ounces make a pound and this practice continued for twenty-five years, or until 1837 when the metric force laws were reimposed,[1] and they have been continued in force until the present day.

Why did the French people revert to their old system as soon as they were given the opportunity? Are not nineteen years of enforced use sufficient to demonstrate the advantages of the metric system if such advantages exist? What explanation of this experience is possible except that the French people found the old system better than the new for the uses to which a system of weights and measures is applied? What other explanation is possible of the general persistence of the Spanish system in Latin America after more than a half century of tutelage? Is it not clear that the people everywhere do not like the metric system because they find it inferior to the older system for the purposes of everyday life?

The Effect of Existing Laws

The effect of the reimposition of the metric system in France in 1837 is shown by the following extract from an official circular letter addressed to local French Chambers of Commerce in 1906 by the

[1] With, however, the omission of the decimal divisions of the year, of the day, and of the circle. What is now called the metric system is but a fragment of that system as devised and understood by its promoters, and for the discontinued parts, the argument is just as good—and just as bad—as for the parts which are still used.

then French Minister of Commerce, Industry and Labor, M. Gaston Doumergue:[1]

"My department at different times has been called upon to give to the Department of Weights and Measures instructions for accomplishing the total suppression of the measures and weights prohibited by the old law of July 4, 1837, by the seizure of the prohibited articles. The department in spite of all such efforts has not succeeded in attaining the desired result. The situation appears to be due to the persistence with which certain trades continue to use the prohibited weights and measures.

"I have learned that in certain industries the advertisements, prospectuses, catalogs, etc., used by the merchants among themselves and also for sending to their customers contain the illegal expressions. The merchants will invoke, without doubt, the necessity under which they find themselves not to change the existing order of things for fear that thereby they may lose orders for their goods. They thus continue to designate in lignes and inches all the articles they sell.

"I do not consider it worth while to enumerate here the industries and professions which have continued to employ the proscribed standards, but they are still numerous and most of them known to members of your organization."

The letter concludes with an appeal to the chambers of commerce to use their influence to bring about a renunciation of this illegal practice. Along with this should go the following from the reply of the Chamber of Commerce at Amiens:

"The Chamber considers that, in view of the customs adopted by certain traders, it seems difficult if not impossible to arrive at a complete suppression of the actual conditions; that, moreover, such a radical and immediate suppression would cause profound disturbance in many industries."

"Such a radical and immediate suppression would cause profound disturbance in many industries"—and this at the end of 112 years of effort and of 70 years of compulsory law!

Note especially that it is in manufacturing industry that the old units are anchored. Reflect that, when the system was adopted in France, modern organized manufacture had scarcely begun; and, remembering that 112 years, backed by national pride of achievement, were found to be insufficient to complete the change under those conditions, the reader should ask himself how many years will be required for the change begun under the present conditions of organized manufacture.

An Example

Light is thrown upon "the industries and professions which," according to M. Doumergue, "have continued to employ the proscribed standards," by the following quotation from the leading French textile journal *L'Industrie Textile*, published 110 years after the adoption of the metric system in France.

[1] The author has in his possession an official copy of this circular letter in the original French.

"It is absolutely unworthy of us French who were the first to find and apply the metric system to retain the *aune* and the *denier* for measuring silk. Ah! these Americans are not considerate of our feelings and they are right. We are as much in the anarchy of weights and measures for the textile industry as at the time of the Revolution, for we have the *denier* of Montpelier and of Milan, for silk, with the *aune* as a unit of length. We still have the diverse standards of Roubaix, Fourmies and Reims for worsted, the *moque* of Sedan, the *livre*, the *quart* and the *sous* of Elboeuf, the *yard* for linen, etc. Ah! the famous *aune*, do you know its equivalent? Exactly 3 feet 7 inches 10 lines and 10 points, or in other words 1.188447 metres, the foot being equal to .324839 metres and divided into 12 inches, the inch into 12 lines and the line into 12 points. [The foot and inch referred to here are the French foot and inch.]

"And this is the reason why they are right in mocking us when they say we do not use the metric system for numbering yarn and for weaving calculations. Nothing is more arbitrary than to reckon the yarn by the thousand metres and the width of the cloth and the picks of the filling by the inch. It is nonsense and a derision. Note also that, while I speak here only of France, I could say as much of all Europe."

The above is but a small portion of the evidence we have regarding the continued use of old units in France but we judge it to be sufficient.

CHAPTER II

THE METRIC SYSTEM IN LATIN AMERICA

The inquiry of which this chapter is a report was conducted through a questionnaire of which about 500 copies were distributed throughout South and Central America and the West Indies. In order to secure representative and impartial distribution, outside agencies were enlisted in the work, the printed blanks being sent to their branches and correspondents by the National City Bank, the United Fruit Company, W. R. Grace and Company, and the Hill Publishing Company. Additional copies were sent out by the author to names taken from a commercial list obtained from the United Fruit Company and to United States consuls.

The questionnaire as drawn up in English will be found in the Appendix to this chapter, together with the form letter which accompanied it. The actual printed forms sent out were translated into Spanish and Portuguese, in which languages most of the replies came back. The information given herein is not, however, limited to that obtained through the questionnaires as various citations in the text point out. In all cases quotations without names attached are from the questionnaires.

SPANISH AND PORTUGUESE WEIGHTS AND MEASURES

As many readers are not acquainted with Spanish weights and measures, tables of the more common units and their relations are here given. The translation of the Spanish names is almost self-apparent, but the following are given:

Onza	Ounce	Pulgada	Inch
Libra	Pound	Pie	Foot
Tonelada	Ton	Vara	Yard
Cuartillo	Quart		

The Portuguese names are so similar that their meanings will be apparent.

SPANISH WEIGHTS AND MEASURES

Weight

16 onzas	= 1 libra
25 libras	= 1 arroba
4 arrobas	= 1 quintal
20 quintales	= 1 tonelada

Dry Measure

4 cuartillos	= 1 celemin
12 celemins	= 1 fanega
12 fanegas	= 1 cahiz

Liquid Measure

4 cuartillos	= 1 azumbre
8 azumbres	= 1 cantara
16 cantaras	= 1 moyo

Length

12 pulgadas	= 1 pie
3 pies	= 1 vara

UNIFICATION OF ENGLISH AND SPANISH WEIGHTS AND MEASURES

With slight differences in the values of the units, this system is substantially identical with our own. With suitable foresight and effort the two might have been unified long ago.

The chief difficulty in the adoption of the metric system in Latin America has been and is the psychological difficulty—that is, learning to think or visualize values in strange units. In this sense the difficulty of adopting the English values of the units would have been nil for there would have been too little change in values to cause confusion of thought, while in names there would have been none.

Meanwhile the still greater difficulty in our own case—the physical difficulty due to the anchorage of units in standardized manufacture—was and is absent in Latin America where but little manufacturing is done. The difficulties in the way of adopting the English values of the units thus were and are trifling in comparison with those in the way of adopting the metric units. Moreover, the process would have been one of subtraction, two sets of values being reduced to one, and, internationally considered, several sets of values reduced to one, for the Spanish units have slight and annoying differences of value in different countries. The "adoption" of the metric system, on the other hand, has been one of addition, another set of units being added to those already existing.

The ease with which the English values of the units might have been adopted is shown by these reports of the progress they have made. With no trace of compulsion or even governmental recognition, they have come into large use by the operation of the forces of trade and commerce and by

simple acceptance, whereas the metric units have nowhere made progress except by compulsion.

The remaining question is: Is it too late? Except for units for land measure, which, once established, should be let alone, I think not, for conditions have not materially changed in Latin America. It must be apparent there, as this inquiry makes it here, that the attempt to adopt the metric system is a failure. The weights and measures of Latin America are in a state of chaos, for which a remedy is sorely needed. Were they to dismiss the intruder and retain the old historic names with changes in values which are so slight as to be inrppreciable for most purposes, Pan-Americanism in this important field would become an accomplished fact, and the unification of the weights and measures of North and South America with those of the British Empire would be within sight.

It is especially to be noted that until about the beginning of the present century there were few, if any, compulsory metric laws in Spanish America. The system had been "adopted" in many of those countries as the official system, and used chiefly for customs purposes and railway tariffs, but the people continued to use the old measures without molestation. The change in the intervening years is due to German influence and for German purposes. If, as seems certain, German influence in Spanish America is to suffer an eclipse, is it too much to hope that the future may see the unification of the weights and measures of North and South America and the British Empire on the foundation of the system which, in its basic and historic features, is common to all?

Meanwhile we have an important lesson to learn from Latin America. A glance through these reports will reveal the common practice of selling grain and other farm products at wholesale by *weight*, the arroba and the quintal being favorite units.

Our clumsy efforts to connect the bushel and pound through conversion factors are the cause of much confusion[1] which would disappear were we to copy this practice, and, incidentally, deprive the metricites of a false argument which is on all their lips, and which the unthinking know no better than to accept. The unit for this purpose should be the quintal of 100 lb.—a name which is preferable to hundredweight as it avoids confusion with the British hundredweight of 112 lb.

GENERAL ANALYSIS OF RESULTS

The effort to learn the relative usage of the different systems has not been successful. When one return gives exclusive use of the metric

[1] It should be noted that the adoption of the metric system would not do away with this confusion since wheat, corn, rye, etc., do not weigh the same per decaliter any more than they do per bushel. The sale of these and similar commodities by *weight* is the simple and sufficient method of abolishing all the confusion now experienced in this branch of trade.

system for a given purpose and another exclusive use of the Spanish system for the same purpose, discrimination is impossible. The thing here proven is that the claim that Latin America is metric is false, as are all arguments based upon it. In particular, it should be noted that the order in which the units are herein named has no significance.

In but one of the countries investigated (Uruguay, which see below) can the metric system be said to be adopted for domestic trade, while from Uruguay we have such reports as these:

Lumber and timber: "Officially the meter, customarily per thousand feet," By carpenters and other woodworkers; "English foot and inch generally used." In machine shops: "Officially the meter and multiples, practically, following the custom, the English inch." Sizes of pipes for gas, water, sewers, etc: "Officially the meter, practically the pulgada." (Pulgada is the Spanish name for inch.) Marine measurements: "Officially the kilometer, to a large extent the marine mile." "In practice there is no effort to abolish completely the English measures."

In other Latin American countries the adoption of the system is much less complete than in Uruguay but, nevertheless, in twelve of these twenty countries according to the Director of the Bureau of Standards,[1] the system is "obligatory."

In ten of these countries (apart from the railroads and other fields under immediate government control) the metric system has made very little impression. (Nicaragua, Guatemala, Spanish Honduras, Cuba, Panama, Colombia, Porto Rico,[2] San Salvador, Ecuador, and Costa Rica, which see below.)

Of these ten countries, according to the Director of the Bureau of Standards, the metric system is "obligatory" in seven.[1] In five of them (Cuba, Colombia, Porto Rico, Panama, and Spanish Honduras, which see below) the English units are used far more than the metric, having largely supplanted all others, although in three of them according to the Director of the Bureau of Standards the metric system is "obligatory."[1] Not only has the English pound come into large use, but the arroba and quintal have been adjusted in value to make them equal to 25 and 100 English pounds, respectively. In substantially all of the countries investigated the English inch is used for mechanical purposes, as the English nautical units are used for navigation and sea shipments. That most derided of English units—the nautical mile—is used by all countries that sail the seas and they use no other. The kilometer is an unknown measure at sea.

[1] See the Metric System in Export Trade by the Director of the Bureau of Standards, page 17; Senate Document No. 241, Government Printing Office, 1916.

[2] Porto Rico is always claimed by the metricites to be metric. Thus, according to Mr. Fred R. Drake, Chairman Executive Committee, American Metric Association, "The meter, liter and gram continue to prove most satisfactory in official and general use in the Philippine Islands, *Porto Rico* and other United States possessions.

In all countries the impression made is in direct relation to the severity of the laws, of which we have the climax in Uruguay (see Uruguay below), with Venezuela and Argentina not far behind. In all cases the movement was begun with mild laws under the impression that the adoption of the system was a simple and easy thing to bring about. Such laws failing, more drastic ones followed, but even these have been but partially effective. The greatest progress has been made in the field of domestic retail trade, in which weights and measures are under the immediate eye of officers of the law.

It is this field which comes under the observation of tourists. One may tour through, or, for that matter, live in a country for many years, in many walks of life, and experience but little contact with weights and measures outside the field of retail trade, and we thus see why the reports of tourists are more favorable to the metric system than the facts justify, as we also see why the observations of tourists, in a comprehensive sense, have very limited value.

The further we get from the field of retail trade, the less is the system used. In this field the progress is chiefly with units of weight and capacity, the measure of length for the sale of drygoods being commonly the vara, while imported wearing apparel of all kinds is commonly sold by the units of the country of its origin, by the inch at least as much as the centimeter, and domestic products are frequently made to numbered sizes, of which the relation to any system of units is not apparent. They are not metric.

In primary or wholesale markets the old measures prevail, although these, in some cases, have been adjusted in value to make them even multiples of English basic units. We have here perfect examples of the simple process of unification of English and Spanish measures which, with proper encouragement, might by this time have become substantially universal.

Lumber and timber are almost universally sawn to the inch, although frequently mixed with the vara or the meter for length, and the square and cubic meter as sales units, prices being made at so much per square or cubic meter for one-inch boards.

In the mechanical trades tailors and seamstresses use all three systems, as do stone and brick masons, while carpenters commonly use the pulgada or inch. In machine shops both English and metric units are used, depending chiefly on the country of origin of the machines they have to repair. The inch is predominant.

In this connection we have the report of the Cleveland Twist Drill Company that shipments of their tools to South America are "95 per cent to 100 per cent English," and of the Detroit Twist Drill Company that "All of our South American customers use more English sizes than

metric." Needless to say, English-sized twist drills are bought in order to make English-sized holes, for they will make no other.

In ship and boat building, also, the English units find large use, while in mining and smelting we find a miscellaneous mixture of all three systems.

The persistence of old units is most pronounced in the measurement of land. When units of measure are once anchored in titles to real estate, they are there to stay. Of this we have perfect examples in the use of the French arpent in Louisiana and the Spanish vara in Texas, in which states those units are today the common units of land measure. Another example is found in France, where, in some sections, the old units of land measure are still predominant.

When outlying districts are incorporated within city limits, parcels of land are much reduced in size and smaller units come in. This gives an opportunity for the introduction of the metric system, but with the result that, in the older portions of the town, the old units are used, while in the newer portions we find the new ones.

Similarly, initial surveys of the *hinterland* give an opportunity for the use of new units, but again with the result that the older portions of the country are measured in one set of units and the newer in another.

In Uruguay, where the laws are more severe and more rigidly enforced than in any other country, it has been found necessary to authorize the use of old units for the measurement of land (see Uruguay below), while in other countries the laws, in this application, are quietly ignored. This is the more significant because all transfers of real estate, as matters of public record, come before the eyes of officers of the law. In other countries, again, the purchase and sale are made in Spanish units and the day is then saved by inserting metric equivalents in the documents of record.

In marine measurements and sea shipments the English system is used everywhere, although mixed with metric units, especially for inland navigation.

Classified in another way, the most-used metric units are those of capacity. Next come those of weight, and, trailing far in the rear, those of length and their correlatives of area. This is in accordance with a law which long ago made itself apparent.

THE REASON WHY COMPULSORY METRIC LAWS FAIL

A few words in explanation of the failure of even drastic laws for the adoption of the metric system are here appropriate. Such laws fail because established and harmless practice cannot, except in a technical sense, be made a crime. Fancy an American grocer arrested, haled to court, fined, and even sent to jail for selling sugar by the pound—a thing

that has been done since the Pilgrim fathers landed at Plymouth Rock. And yet this is exactly what they do in Uruguay. Place a meter and a yardstick alongside. They differ in value by about 10 per cent. Is it conceivable that selling by one can be made a virtue and by the other a crime? Fancy an American jury convicting a merchant of a crime for selling drygoods by the yard! And yet this is precisely the meaning of compulsory laws.

It is a truism of law that excessive penalties cannot be enforced and so defeat themselves, and is it not clear that compulsory metric laws in any country in which the people have rights are unenforceable, and that the more drastic they are, the more unenforceable they become? And is it not equally clear that such laws invite oppression and hardship at the hands of an enthusiastic bureaucrat such as we are rapidly placing in power at Washington?

TREATMENT OF GENERAL AND OBSCURE REPLIES

In the following summary, Spanish and Portuguese names are used for Spanish and Portuguese, and English names for English, units. In a few cases returned questionnaires in English have used the word *pound* when those in Spanish from the same countries have used *libra*. In such cases, pound has been taken as meaning libra. Again, pulgada or pollegada has been used for commodities (e.g., pipe) which are obtained from the United States and Great Britain and in such cases those words have been understood to mean inch.

The English inch is used so much in Latin America that in these reports it is sometimes called the pulgada without qualification. This, in a few cases, has made it impossible to distinguish with certainty between the pulgada and the inch. The same condition and remark apply, although to a smaller degree, to the libra and pound, *but in neither case is there any uncertainty regarding the non-use of the metric units.*

When the reports show, as they often do, sales to be made by the unit, dozen or hundred, the information has been omitted as having no significance. Similarly, such expressions as "by arrangement," "bale," "sack," "as per contract," "in packages of various weights," "by weight," "conventional," "lineal and square measures," "no fixed standard," "load of an animal," "special standards," of which there are many, convey no definite information and have been ignored. The expressions "American measurements" and "English measurements" have been translated into English units when they are sufficiently well defined by custom. The expressions "metric" and "metric system" have been treated similarly when the units used are known or made clear in other questionnaires, but it has sometimes been necessary to use the inclusive term "metric." "English system" and equivalent expressions have also been

used in some cases. In several reports on wearing apparel, numbered sizes are given. In some cases these are clearly inches or centimeters and have been so translated. In other cases they are local and impossible to translate into any system of units, and have been so given.

The word quintal (in some countries called cental) invariably means the Spanish quintal of 100 libras, and, similarly, tonelada means the Spanish ton of 2000 libras. In those cases ni which the metric quintal of 100 kilograms and the metric tom of 1000 kilos have been reported, those units are designated as metric quintal and metric ton. Some of the reports show incongruous units for certain purposes, but they are, of necessity, repeated here.

THE RESULT OF A GREAT SERIES OF EXPERIMENTS

We have in this Report a composite picture of the result of many attempts to adopt the metric system, that result being uniformly the addition of that system to those previously prevailing, and it is this that we must contemplate as the result of the attempt to adopt it here. We must compare what we have with what we will get, not with what one may hope we will get. Moreover, it must be noted that had all these countries succeeded in this great experiment, it would have no significance for our guidance, because of the greater importance of our manufacturing industries. France adopted the system before the beginning of the manufacturing era, and Germany adopted it before the development of manufacturing in that country. Everyone knows that the rise of Germany as a manufacturing nation began after the war of 1870. South American countries are not manufacturing countries. More manufacturing is done in the city of Philadelphia than in all South America.

We see then that, in western Europe, the system was adopted before the development of manufacturing and that manufacturing has developed with and in it, while in South America practically no manufacturing is carried on.

Great Britain and we are the first to be asked to change our manufacturing units for which there is not a shadow of a precedent.

Seldom has an effort of such magnitude been made. We have here a record of twenty experiments on a national or, collectively, a continental scale, and their net result is to demonstrate the wisdom of the conclusion arrived at by John Quincy Adams after four years of investigation and nearly a century ago:

> "The substitution of an entire new system of weights and measures instead of one long established and in general use, is one of the most arduous exercises of legislative authority. There is, indeed, no difficulty in enacting and promulgating the law, but the difficulties of carrying it into execution are always great and have often proved insuperable.

"The legislator . . . finishes by increasing the diversities which it was his intention to abolish, and by loading his statute books only with the impotence of authority and the uniformity of confusion."

It is to protect our country from this "uniformity of confusion" that we are fighting.

THE RESULTS ARE NOT SURPRISING

Some who read this chapter will, no doubt, be surprised at the condition disclosed in Spanish and Portuguese America, but there is no reason why any one should be surprised as no one has seen the first scintilla of proof to the contrary. Assertions and assumptions have been repeated so many times that, no doubt, in some cases, they have been accepted as true, but no proof has been presented and there is no proof. On the contrary, those who know weights and measures, who know the gigantic character of the task which confronts any nation which sets out to change them, know that the inherent probabilities are all in favor of the condition set forth.

Do not confound legislation for the adoption of the metric system with its real adoption. All experience shows that while such legislation is fatally easy, the adoption of the system is impossible, the effect of the laws being to bring about nothing but the confusion and disorder that prevail throughout Latin America. Every success in the attempt to persuade some interest to introduce the system is but a step toward the confusion that prevails throughout Latin America. We have there twenty countries in which the experiment has been made with the uniform result of grotesque failure. Every expectation has been falsified and every prediction inverted. Shall we take warning, or shall we plunge headlong into this metric morass?

Following are the summarized replies to the questionnaires:

ARGENTINA

(Summary of eleven returned questionnaires)

Groceries: Kilogram, liter, pound. *Fruits:* Kilogram. *Milk:* Liter. *Butter and Cheese:* Kilogram. *Other Farm Products:* Kilogram, liter. *Hardware:* Kilogram, centimeter, inch, meter, yard. *Fish:* Kilogram. *Meat:* Kilogram. *Flour:* Kilogram. *Tea and Coffee:* Kilogram.

Dry Goods: Meter, yard. *Fuel:* Kilogram. *Tobacco:* Kilogram.

Ready-made Clothing: Centimeter, inch, local numbers. "The measurements of these articles are expressed in the trade in English or metric units according to their source. Clothing, collars, hats, etc., imported from England are measured in inches and those from France in metric units." *Hats:* Centimeter, local numbers, inch. (See clothing above.) *Collars:* Centimeter, inch. "Best stores have conversion tables to inches." (See clothing above.) *Underwear and Hosiery:* Inch, centimeter. *Shoes:* Centimeter. "Imported shoes in English sizes. Local manufactures to special Argentine numbers." "The point corresponding to one-quarter of the old French inch." *Gloves:* Centimeter. *Corsets:* Centimeter.

For the Measurement of Land: Hectare, square meter, cuadra, league, vara. "Lots of land are sold in most cases by the square vara." "In many places the vara is used, also the cuadra, but these measures are not legal." "In Buenos Aires the old vara is still quite frequent." "The real estate dealers are accustomed to sell city lots by the square vara, although according to law they are liable to a severe penalty."

Lumber and Timber: Inch, foot, meter. "English measurements, though some sales are based on length in meters." "Length always in meters, breadth and thickness more often in inches." "Chiefly English measures." "By the cubic meter and square meter for 1 inch in thickness."

By Carpenters and other Woodworkers: Metric, English. *By Stone and Brick Masons:* Metric. *By Tailors and Seamstresses:* Meter, centimeter.

In Machine Shops: Meter, inch, millimeter, centimeter, gram, kilogram. "Sizes in English measures." "Iron measurements in inches, otherwise kilo and centimeter."

In Contracts for Excavation of Ground: Cubic meter, square meter, kilogram. *In Mines and for Mining Products:* Metric ton, kilogram, meter. *In Smelting and for Smelter Products:* Meter, pulgada, kilogram, metric ton. *Sizes of Pipe for Gas, Water, Sewers, Etc.:* Length, meter; diameter, meter, foot, inch; weight, kilogram. "Meter for large sewer pipes; soil pipes, English and metric; gas and water pipes, inch."

In Ship and Boat Building: Meter, foot, inch, kilogram. *Marine Measurements:* Kilometer, meter, pie, ton, mile, knot, cubic foot. "Distances, maritime miles; charts, feet; tonnage and displacement, same as England and United States." "English measures." "As regards marine measurements, although contrary to legal provisions, people use for distance the marine mile. Charts of bays: Depths are expressed in English feet or in fathoms of 6 ft. Tonnage is expressed in Moorson tons. Displacement is expressed in English tons. Freight, English ton, metric ton."

Hay at Wholesale: Kilogram, metric ton. *Grain at Wholesale:* Quintal, hectoliter, kilogram. *Meat at Wholesale:* Kilogram. *Root Crops at Wholesale:* Kilogram. *Coffee at Wholesale:* Kilogram. *Milk at Wholesale:* Liter. *Butter and Cheese at Wholesale:* Kilogram. *Garden Products at Wholesale:* Kilogram. *Rubber at Wholesale:* Kilogram.

Railway Tariff for Passengers and Freight (Load and Distance): Kilogram, metric ton, kilometer. *Loads and Rates for City Transportation:* Kilogram, metric ton. *Loads and Rates for Transportation by Muleback Across the Mountains:* Kilogram. *Railway Track Gages and Length of Lines:* Distances, kilometer; gage, English, metric. *Railway Equipment (units used in the construction and repairing of locomotives, cars, etc.):* English, metric.

"The only legal units for any business transaction are the metric system, but through a bad habit there has been introduced in common language the indiscriminate use of the American and Canadian legal measurements."

Mr. E. F. Du Brul writes from Buenos Aires: "Many quotations on the market are made in tons, pounds, etc. City land is sold by the square vara. Wine, etc., is sold by the pipe and barrel. I notice advertisements in the street cars of wine sold by the frasco. As large estancias change hands they are sold by the square legua. I notice that there is one ton of 918.8 kilos. I have run into a few others; for example, a metric ton of 1000 kilos; another of 1004 kilos; another of 1016 kilos, and another of 1018 kilos. Many building operations are conducted on the old Spanish measurements. Machinists and others are extremely familiar with English measurements as well as Spanish and metric because they have to use all three of them." Mr. Du Brul encloses a price list of files made in Germany and sold in Buenos Aires, and the lengths are given in all cases in pulgadas.

According to a standing announcement in THE JOURNAL of The American Society of Mechanical Engineers, the Republic of Argentina specifies that all steam boilers

for government use are to be made to the Society's code. This code is the most elaborate piece of standardization ever undertaken. It includes a profusion of formulæ and specifications of the properties of materials and the strength of all parts *in English units exclusively.*

The Boston Pressed Metal Company write: "Shipments to Argentine are handled by our agent at Buenos Aires and standard English sizes are accepted and used without question. In fact, there has never been any suggestion that metric sizes were required or preferred."

According to the Report to the International High Commission on The Metric System in Export Trade, prepared by the Director of the Bureau of Standards, the metric system is "obligatory" in Argentina.

Argentina "adopted" the metric system in 1863.

BOLIVIA

The report of Mr. W. A. Graham Clark, Commercial Agent of the Department of Commerce and Labor, Part IV, published by the Department in 1911, contains the following: "Bolivia has officially adopted the metric system, but the old Spanish weights and measures are those commonly used. All cloth is retailed by the vara."

BRAZIL

(Summary of thirty-seven returned questionnaires)

Groceries: Liter, kilogram, gallao, arroba, gram. *Fruits:* Kilogram, arroba, alqueire; conserves in ½-kilo cans. *Milk:* Liter, garrafa of ⅔ liter. *Butter and Cheese:* Kilogram, libra; butter in packages of ½, 1 and 7 pounds and ¼, ½, 1, and 3 kilograms. *Other Farm Products:* Cargueire quarta, kilogram, metric pound, liter, arroba. *Hardware:* Inch, kilogram, meter, centimeter, millimeter, metric ton, liter (*sic*). "Use all measures." *Fish:* Kilogram. *Meat:* Kilogram, liter (*sic*), arroba. *Flour:* Liter, kilogram, alqueire. *Tea and Coffee:* Tea in cans of ¼, ½, 1 and 5 English pounds and by kilogram; coffee, kilogram.

Dry Goods: Meter, jarda, covado.

Fuel: Wood, cubic meter, carroca, cargueire; coal, metric ton, kilogram; oil, kilogram and liter.

Tobacco: Kilogram, meter, arroba; fine tobacco, onca.

Ready-made Clothing: Centimeter, meter. *Hats:* Brazilian, English, Italian and Portuguese numbers, centimeter, inch meter (*sic*). *Collars:* Centimeter, meter (*sic*). *Underwear and Hosiery:* Underwear, centimeter; hosiery, inch, centimeter, meter. *Shoes:* Centimeter, numbered sizes by no apparent system, English, Portuguese, meter (*sic*). *Gloves:* Letter sizes, numbered sizes by no apparent system, centimeter, inch. *Corsets:* Centimeter, meter (*sic*).

For the Measurement of Land: In the farming districts: Meter, square meter, alqueire, hectare, leagua, braca, are, palmo, pollegada (*sic*), paulista, front foot, tarefa. "For agricultural lands or open lands in general the division is almost universally into alqueires." "The old Brazilian leagua is generally used." "The standard throughout the State is the alqueire." In the smaller towns: Braca, alqueire, square meter, tarefa, vara, hectare, palmo, front meter, are, pollegada (*sic*). In cities: Meter, square meter, braca, are, palmo, pollegada (*sic*), hectare.

Lumber and Timber: Palmo, foot, inch, pie, pollegada, meter and palmo for length, square foot, cubic meter, centimeter. "Thickness of lumber always in English inches. Width in English inch by the lumber company, and Portuguese inch by others. The lengths in feet by the lumber company and Portuguese inches by others."

By Carpenters and Other Woodworkers: Meter, inch, foot, palmo, pollegada, centimeter. *By Stone and Brick Masons:* Meter, cubic meter, square meter, pollegada, centimeter, palmo. *By Tailors and Seamstresses:* Meter, centimeter.

In Machine Shops: Meter, foot, inch, palmo, kilogram, metric ton, gram, liter (*sic*). "The metric system was established by law under the Empire as the only official system. The English system, especially for metal work, is very popular."

In Contracts for Excavation of Ground: Cubic meter, palmo, braca. *In Mines and for Mining Products:* Meter, cubic meter, metric ton, kilogram, gram, oitavo, carat. *In Smelting and for Smelter Products:* Cubic meter, metric ton, inch (*sic*), centimeter, (*sic*), kilogram, gram. *Sizes of Pipe for Gas, Water, Sewers, Etc.:* Inch, centimeter, meter for length. "English system chiefly; metric system infrequently." "For the measurement of earthen pipes, the internal diameter is usually given in inches. Metal tubing for gas and water is measured by weight, per kilogram. Diameters are usually measured in inches and lengths in meters." "The English measures prevail."

In Ship and Boat Building: Meter, yard, foot, inch. "Generally the English foot; exceptionally the meter." *Marine Measurements:* Marine mile, foot for harbor charts, meter; freight by metric ton, cubic meter, kilogram; depths in meters or feet; knot, league. "English mile for distance; English foot for drafts." "English system." "The nautical mile is most commonly employed; Lloyds' registry is used in calculating tonnage." "Distances, English mile; tonnage, English ton; draft, English foot."

Hay at Wholesale: Arroba, kilogram. *Grain at Wholesale:* Liter, kilogram, prato, cargueiro quarta, alqueire, arroba. *Meat at Wholesale:* Kilogram, arroba. *Root Crops at Wholesale:* Kilogram, arroba, amarrado, metric ton. *Coffee at Wholesale:* Kilogram, arroba. *Milk at Wholesale:* Liter. *Butter and Cheese at Wholesale:* Kilogram, libra, jaca, arroba. *Garden Products at Wholesale:* Liter, kilogram. *Rubber at Wholesale:* Kilogram, arroba.

Railway Tariff for Passengers and Freight (Load and Distance): Kilometer, metric ton, cubic meter. *Loads and Rates for City Transportation:* Kilometer, tonelada, cubic meter, arroba, metric ton, kilogram. *Loads and Rates for Transportation by Muleback Across the Mountains:* Arroba, kilogram. *Railway Track Gages and Length of Lines:* Meter, kilometer, centimeter. *Railway Equipment (units used in the construction and repairing of locomotives, coaches, etc.):* Inch, foot, kilogram, meter. "Weight, kilo; measure, English inch."

"The official system of weights and measures, etc., is the metric system. However, the old Brazilian system is still commonly used."

According to the Report to the International High Commission on The Metric System in Export Trade, prepared by the Director of the Bureau of Standards, the metric system is "obligatory" in Brazil.

Brazil "adopted" the metric system in 1862.

CHILE

(Summary of ten returned questionnaires)

Groceries: Libra, kilogram. "Generally the libra." *Fruits:* Libra, kilogram. *Milk:* Liter, hectoliter, botella = ⅔ liter. *Butter and Cheese:* Libra, kilogram. *Other Farm Products:* Libra, kilogram, quintal, fanega. *Hardware:* Libra, kilogram. *Fish:* Libra, kilogram. *Meat:* Kilogram, libra. "Live cattle, kilo; meat, libra." *Flour:* Libra, kilogram, arroba, quintal. *Tea and Coffee:* Libra, fanega, quintal, kilogram.

Dry Goods: Vara, yard, meter. "Wholesale, yard; retail, vara."

Fuel: Kilogram, raja, cubic meter, decaliter (*sic*), almud, fanega, tonelada, metric ton, cordada.

Tobacco: Libra, quintal, kilogram, gram.

Ready-made Clothing: Centimeter, inch. "As in United States and England." *Hats:* Local numbers, inch, centimeter. *Collars:* Centimeter. *Underwear and Hosiery:* Centimeter, inch. "As in the United States." *Shoes:* Centimeter. *Gloves:* "English sizes," local numbers, centimeter. *Corsets:* Centimeter, inch. "French and English," "English sizes."

For the Measurement of Land: In the farming districts: Hectare, cuadra, caballeria, leagua. In the smaller towns: Hectare, meter, cuadra, square meter, caballeria, potrero. In cities: Square meter, square vara.

Lumber and Timber: Inch, square foot, foot, board foot, cubic yard. "Sizes as in United States." "Length of native wood in Spanish varas."

By Carpenters and Other Woodworkers: Inch, foot, square foot. "The measures generally used are the foot and inch, rarely the meter." "The meter is sometimes used for the sizes of beams." *By Stone and Brick Masons:* Square meter, cubic meter, inch, centimeter. *By Tailors and Seamstresses:* Centimeter, meter, vara.

In Machine Shops: Inch, foot. "In repair work on English and American machinery, feet and inches; on German, French and Italian, metric."

In Contracts for Excavation of Grounds: Cubic meter, vara, pie. *In Mines and for Mining Products:* Quintal, cubic meter, kilogram, tonelada, metric ton. "Long ton for ores for England; short tons for American purchase; metric for local smelters; Troy and metric for assays." *In Smelting and for Smelter Products:* Tonelada, kilogram, cubic meter, quintal. *Sizes of Pipe for Gas, Water, Sewers, Etc.:* Inch, foot, centimeter for sewer pipe.

In Ship and Boat Building: Tonelada, pie, pulgada, foot, inch, meter, centimeter. *Marine Measurements:* Mile, knot, kilometer, braza (fathom), ton. "For distances, the English mile; for charts of bays, the meter; for tonnage, the metric ton; for displacement, the metric ton; for freight and bulk, meter and metric weight." "English maritime mile."

Hay at Wholesale: Fanega, metric ton, kilogram, quintal, metric quintal, arroba. *Grain at Wholesale:* Fanega, arroba, quintal, metric quintal, kilogram, hectogram. *Meat at Wholesale:* Kilogram. "Wholesale, per kilo; retail, per libra." *Root Crops at Wholesale:* Quintal, libra, kilogram, arroba. *Coffee at Wholesale:* Quintal, fanega, kilogram, metric quintal. *Milk at Wholesale:* Hectoliter, liter, botella (⅔ liter). *Butter and Cheese at Wholesale:* Libra, quintal, kilogram, arroba. *Garden Products at Wholesale:* Quintal, kilogram, arroba. *Rubber at Wholesale:* Quintal.

Railway Tariff for Passengers and Freight (Load and Distance): Metric quintal, tonelada, kilogram. *Loads and Rates for City Transportation:* Quintal, tonelada, cubic meter. *Railway Track Gages and Length of Lines:* Meter, kilometer. *Railway Equipment (units used in the construction and repairing of locomotives, cars, etc.):* Kilogram, inch, foot, quintal.

"The addition of the metric system has merely added an additional system without any visible advantage. So long as the Anglo-Saxon dominates in the manufacturing world, feet, inches and pounds will be used here." "All measures are mixed. Besides metric, avoirdupois weight and feet there are many Spanish and local measures like the cajon, marco, fanega, Spanish quintal, etc." "The libra is most frequently used in the purchase and sale of goods for daily consumption." "In machine shops it may be said that up to the present the foot and inch have predominated." "The sales of the leading product of this section, nitrate of soda, are made commercially in Spanish quintals." "The Chilian hydrographic charts have scales in several units—cables, meters and geographic miles."

The report of Mr. W. A. Graham Clark, Commercial Agent of the Department of Commerce and Labor, Part IV, published by the Department in 1911, contains the following: "Chile has officially adopted the metric system, but in the shops throughout the country the vara is still the recognized length for retail selling."

According to the Report to the International High Commission on The Metric System in Export Trade, prepared by the Director of the Bureau of Standards, the metric system is "obligatory" in Chile.

Chile "adopted" the metric system in 1858.

COLOMBIA

(Summary of five returned questionnaires)

Groceries: "Pound and arroba of 25 English pounds," kilogram, quintal. *Fruits:* Pound, kilogram, quintal, arroba. *Milk:* Botella of 360 and 750 grams. *Butter and Cheese:* Pound, libra, arroba, metric pound. *Other Farm Products:* Pound, arroba, kilogram, quintal. *Hardware:* "American and English measurements generally." "English pound or arroba of 25 English pounds." *Fish:* Pound, "arroba of 25 English pounds." *Meat:* Pound, libra, arroba. *Flour:* Libra, pound. *Tea and Coffee:* Libra, pound, ounce, kilogram.

Dry Goods: Yard, vara, meter. "Cloths are sold indiscriminately by meters, varas, or yards according to the origin of the goods or the whim of the buyer."

Fuel: Kilogram, burro, arroba, metric ton, English ton and pound.

Tobacco: Libra, arroba, pound.

Ready-made Clothing: "American and French measurements." *Hats:* "American and French measurements." "Spanish sizes." *Collars:* "American and French measurements." *Underwear and Hosiery:* "American and French measurements." "Spanish sizes." *Shoes:* "American and French measurements." "Spanish sizes." *Gloves:* "American and French measurements." *Corsets:* "American and French measurements."

For the Measurement of Land: In the farming districts: Hectare, fanegada, cabuya. In the smaller towns: Cabuya (50 brazas), square vara. In cities: Square vara, square meter, square yard. "The real-estate documents always give the measure that is used indiscriminately."

Lumber and Timber: Square foot, metric, "Standard board sizes in inches."

By Carpenters and Other Woodworkers: Square foot, "Feet and inches and metric system about equally." *By Tailors and Seamstresses:* Metric, inch. *By Stone and Brick Masons:* Square foot.

In Machine Shops: Meter, foot, "English system."

In Contracts for Excavation of Ground: Cubic meter. *In Mines and for Mining Products:* "English." *In Smelting and for Smelter Products:* "English." *Sizes of Pipe for Gas, Water, Sewers, Etc.:* "English measures."

In Ship and Boat Building: Cubic ton, "English measures." *Marine Measurements:* Mile, "Metric measurements and weights." "The braza, which corresponds to the English fathom. The English nautical league and mile, English ton and short ton; occasionally the metric ton. Displacement ton as above (English). Freight per metric ton."

Grain at Wholesale: Hectare (*sic*), pound, arroba, quintal. *Meat at Wholesale:* Pound, arroba. *Root Crops at Wholesale:* Pound, kilogram, arroba, manojo, ton. *Coffee at Wholesale:* Kilogram, arroba, quintal. *Milk at Wholesale:* Contara, botella. *Butter and Cheese at Wholesale:* Pound, arroba, metric pound. *Garden Products at Wholesale:* Pound, kilogram, arroba, quintal. *Rubber at Wholesale:* Pound, arroba, quintal, metric ton.

Railway Tariff for Passengers and Freight (Load and Distance): Kilometer. *Loads and Rates for City Transportation:* Arroba, mile, pound. *Loads and Rates for Transportation by Muleback across the Mountains:* Arroba, mile.

Railway Track Gages and Length of Lines: Inch, foot, meter, kilometer.

"The pound in this region is the English because all the machines, platform scales and weighing instruments come from England and the United States." "As you can see, we have no uniformity of weights and measures in this country." The report of Mr. W. A. Graham Clark, Commercial Agent of the Department of Commerce and Labor, Part II, published by the Department in 1910, contains the following: "An instance of the conservatism of the retail merchants in this respect was strikingly shown during the recent civil war, when the Bogota importers found it necessary to get some white goods from the Barranquilla importers. On arrival the importers found them almost unsalable because they were in the coast lengths of 20 yards instead of the customary Bogota lengths of 24 yards. It would seem that, as the goods are finally retailed by the vara, the length of cuts would be immaterial, but according to the importers it has a strong effect on the salability of the cloth, and this peculiarity must be catered to in order to obtain the business."

According to the Report to the International High Commission on The Metric System in Export Trade, prepared by the Director of the Bureau of Standards, the metric system is "obligatory" in Colombia.

Colombia "adopted" the metric system in 1853.

COSTA RICA

(Summary of three returned questionnaires)

Groceries: Libra, cajuela, fanega, quintal. *Fruit:* Domestic, no standard; imported, libra. *Milk:* Liter, botella (⅕ gallon). *Butter and Cheese:* Libra, arroba. *Other Farm and Garden Products:* Libra, cuarillo, fanega, cajuela, quintal. *Hardware:* Pie, vara, libra, pound. *Fish:* Libra, quintal. *Meat:* Kilogram, libra. *Flour:* Quintal, half quintal, libra. *Tea and Coffee:* Quintal, libra.

Dry Goods: Vara, yard.

Fuel: Coal, libra; charcoal, cuartillo; wood, no defined unit.

Ready-made Clothing: Inch, centimeter. *Hats:* Inch. *Collars:* Inch, centimeter. *Underwear and Hosiery:* Inch, centimeter. *Shoes:* English numbers, French numbers. *Gloves:* Inch. *Corsets:* Inch.

Measurement of Land: In agricultural districts: Hectare, square vara, manzana, are. In the smaller towns: Hectare, square pie, square vara, square meter. In cities: Hectare, square pie, square vara, manzana, square meter. "The people in their transactions generally use the manzana and square vara, but the registry of documents in the government office is based entirely on the meter and the hectare."

Lumber and Timber: Lineal and cubic pie, tonelada of 27 cubic pies, ton of 1000 kilos, foot and vara for length, inch for thickness.

By Carpenters and Other Woodworkers: Superficial and cubic pie, meter, foot, vara, yard. "Indiscriminately the English foot, the Spanish vara, yard and meter." *By Tailors and Dressmakers:* Yard, vara, meter.

In Machine Shops: Quintal, libra, meter, vara, foot, yard, pound.

In Contracts for the Excavation of Ground: Tonelada, cubic meter, cubic vara, cubic foot, cubic yard, cubic meter. *In Mines and Mineral Products:* Metric ton, tonelada, ounce. *Smelting and Smelter Products:* Foot, vara, yard, meter, libra, kilogram. *Pipe Sizes:* Inch, foot.

Ship and Boat Building: Cubic ton. *Marine Measurements:* Mile, league. *Hay at Wholesale:* Bale of 30 to 50 libras. *Grain at Wholesale:* Quintal, fanega, cajeula,

cuartillo. *Meat at Wholesale:* Kilogram, quintal. *Root Crops at Wholesale:* Quintal, bag of 160 liters. *Coffee at Wholesale:* Quintal, tonelada. *Milk at Wholesale:* Botella. *Butter and Cheese at Wholesale:* Quintal, arroba. *Garden Products at Wholesale:* Quintal, bag of 160 liters. *Rubber at Wholesale:* Quintal.

Railway Tariff: Passengers per mile; freight per quintal, kilo, metric ton, cubic pie, cubic ton, cubic meter per kilometer. *Urban Transportation:* Quintal. *Mule-back Transportation Across Mountains:* Arroba. *Railway Gage:* Feet and inches.

"Although the law No. 35 of July 17, 1884, established the metric system as obligatory, the people and the merchants do not use it ordinarily in their transactions."

According to the Report to the International High Commission on The Metric System in Export Trade, prepared by the Director of the Bureau of Standards, the metric system is "obligatory" in Costa Rica.

Costa Rica "adopted" the metric system in 1858.

CUBA

(Summary of three returned questionnaires)

Groceries: Libra, quintal. *Fruits:* Libra. *Milk:* Botella. *Butter and Cheese:* Libra. *Other Farm Products:* Libra. *Hardware:* "English measures." *Fish:* Libra. *Meat:* Libra. *Flour:* Libra. *Tea and Coffee:* Libra. *Dry Goods:* Vara, yard.

Fuel: Libra, cuerda.

Tobacco: Libra, quintal.

Ready-made Clothing: Inch, "American measures." *Hats:* Centimeter, "American measures." *Collars:* Inch, centimeter. *Underwear and Hosiery:* Inch, centimeter, "American measures." *Shoes:* Centimeter, "American measures." *Gloves:* Centimeter, inch, "American measures." *Corsets:* Inch, centimeter, "American measures."

For the Measurement of Land: In the farming districts: Caballeria, leagua, carreaux, "the equivalents being inserted in all public documents according to law." In the smaller towns: Caballeria, vara, meter, cubana. In cities: "Parcels of 1000 square varas."

Lumber and Timber: Foot, inch, kilogram (*sic*).

By Carpenters and Other Woodworkers: Foot, inch, kilogram (*sic*). *By Tailors and Seamstresses:* Meter, centimeter. *By Stone and Brick Masons:* Meter, foot, inch, kilogram (*sic*).

In Machine Shops: Inch, centimeter, pound.

In Contracts for Excavation of Ground: Cubic meter. *In Mines and for Mining Products:* Ton, metric. "Transactions with the United States in feet, inches and pounds." *In Smelting and for Smelter Products:* Centimeter, inch. *Sizes of Pipe for Gas, Water, Sewers, Etc.:* Inch.

In Ship and Boat Building: Foot, inch, meter, ton. *Marine Measurements:* League, ton, mile, "foot for depth."

Hay at Wholesale: Pound, English quintal. *Grain at Wholesale:* Pound, English quintal. *Meat at Wholesale:* Pound, Spanish and English quintal. *Root Crops at Wholesale:* Pound, English quintal. *Coffee at Wholesale:* Pound, English and Spanish quintal. *Milk at Wholesale:* Botella. *Butter and Cheese at Wholesale:* Pound, English quintal. *Garden Products at Wholesale:* Pound.

Railway Tariff for Passengers and Freight (Load and Distance): Meter, kilogram, kilometer. *Loads and Rates for City Transportation:* Meter, kilogram. *Railway Track Gages and Length of Lines:* Foot, inch, kilometer. *Railway Equipment* (*units used in the construction and repairing of locomotives, cars, etc.*): "American and English equipment."

"American measures generally used and in each industry the name is used corresponding with the English meaning."

The report of Mr. W. A. Graham Clark, Commercial Agent of the Department of Commerce and Labor, Part I, published by the Department in 1909, contains the following: "Though the metric system of weights and measures is the official and legal system in Cuba, some of the Spanish weights and measures are still largely used, among them being the arroba and the vara. Cloth is bought by the importer by the meter or yard, and is retailed in the shops by the yard or the vara, the vara being more commonly used."

According to the Report to the International High Commission on The Metric System in Export Trade, prepared by the Director of the Bureau of Standards, the metric system is "obligatory" in Cuba.

DOMINICAN REPUBLIC

Commerce Reports, published by the Department of Commerce, prints the following communication, dated February 20, 1918, from Consul Arthur McLean of Puerto Plata: "The metric system of weights and measures has been legally adopted by the Dominican Republic. The only places, however, where the metric system is applied to trade here is in the municipal markets; avoirdupois weights are used in all other mercantile transactions, although the metric system is in force in the customs and other Government institutions. The kilometer and the league are the two units most generally used in computing distances. Jobbers use the English yard in selling cotton goods to the retailers, while the latter in turn sell to their customers by the vara or Spanish yard, measuring 33 inches. While quotations may be made by American houses to their clients in the Dominican Republic in either metric or English units, the latter are equally acceptable, if not preferred."

ECUADOR

(Summary of five returned questionnaires. One of the questionnaires, in English, reports pounds where, in view of the others, libras are probably meant and are so here reported.)

Groceries: Libra, quintal. *Milk:* Liter, gallon. *Butter and Cheese:* Libra, arroba, quintal. *Other Farm Products:* Arroba, quintal. *Hardware:* Libra, arroba, quintal; pipe by the foot, sheet iron and zinc by the pound, nails and tacks by the pound and ounce. *Fish:* Arroba, quintal. *Meat:* Libra, kilogram. *Flour:* Libra, kilogram, quintal. *Tea and Coffee:* Libra. *Dry Goods:* At retail, vara; at wholesale, yard, meter.

Tobacco: Libra, quintal.

Ready-made Clothing: Inch. *Hats:* Centimeter. *Collars:* Centimeter. *Underwear and Hosiery:* Inch, centimeter. *Shoes:* Centimeter, English sizes. *Gloves:* Centimeter, inch. *Corsets:* Centimeter, inch.

For the Measurement of Land: In the farming districts: Hectare, cuadra, square meter. In the smaller towns: Square meter, cuadra. In cities: Square meter, vara. "In the cities the buildings are measured by the meter, the lots by the vara."

Lumber and Timber: Square foot, pie, foot, pulgada, inch, centimeter; length in varas, circumference in palmas.

By Carpenters and Other Woodworkers: Square foot, pie, pulgada, vara. *By Tailors and Seamstresses:* Centimeter.

In Machine Shops: Centimeter, millimeter, pulgada, inch, meter. "The common standard is the English inch."

In Contracts for Excavation of Ground: Square meter, cubic meter, vara. *In Mines and for Mining Products:* Kilogram, ton, tonelada, quintal. *In Smelting and for Smelter Products:* Quintal, pound, kilogram. *Sizes of Pipe for Gas, Water, Sewers, Etc.:* Inch, centimeter, meter for length.

In Ship and Boat Building: Ton, meter, vara. *Marine Measurements:* Kilometer, meter, vara, league, metric ton, English ton, tonelada, mile, knot, braza, paja, malina, buey.

Hay at Wholesale: Quintal. *Grain at Wholesale:* Fanega, quintal. *Meat at Wholesale:* Kilogram. *Root Crops at Wholesale:* Kilogram, quintal. *Coffee at Wholesale:* Quintal. *Milk at Wholesale:* Gallon "of 4 liters," liter. *Butter and Cheese at Wholesale:* Libra. *Rubber at Wholesale:* Quintal, kilogram.

Railway Tariff for Passengers and Freight (Load and Distance): Kilometer. *Loads and Rates for City Transportation:* Weight, cubic pie. *Railway Track Gages and Length of Lines:* Meter, kilometer, inch. *Railway Equipment (units used in the construction and repairing of locomotives, coaches, etc.):* American.

"The Spanish inch, foot and ton are used as are other measures, although the metric measurements are sometimes used." "The Spanish pound is used in weighing everything." "While the metric system is legal, it is not enforced."

(Reply to a questionnaire sent out by Mr. Henry R. Towne)

Legal Standards: Metric system used by the Government.

Common Standards: The public uses generally the old Spanish (Castilian) measures the vara, the libra, and the gallon.

Commercial Use: Metric system used in business with foreign countries, except the United States and Great Britain, in which case the British system is used. In domestic business only the Spanish system is used.

Domestic Use: Only the Spanish system in domestic use.

Measuring Implements: Spanish measures chiefly.

Dual Standards: The old Spanish (Castilian) is preferred simply as a matter of habit "handed down by the Conquistadors."

Adoption of Metric System: Metric system adopted about 30 years ago.

Bookkeeping, Invoicing, Etc.: Bookkeeping about half in metric and half in old Spanish units, but only the latter used in making out domestic invoices. Foreign invoices about 90 per cent. metric and 10 per cent. old Spanish. Business records about half and half.

The report of Mr. W. A. Graham Clark, Commercial Agent of the Department of Commerce and Labor, Part IV, published by the Department in 1911, contains the following: "Cloth is bought and sold by the importer by the yard, meter or vara, but is always retailed by the vara."

Ecuador "adopted" the metric system in 1856.

GUATEMALA

(Summary of four returned questionnaires)

Groceries: Libra, quintal. *Milk:* Liter. *Butter and Cheese:* Libra. *Fish:* Libra. *Meat:* Libra. *Flour:* Libra, quintal. *Tea and Coffee:* Libra.

Dry Goods: Vara.

Fuel: Carga, red.

Tobacco: Libra.

Ready-made Clothing: Inch. *Hats:* Inch, centimeter. "The two standards are used indifferently." *Collars:* Inch, centimeter. "The two standards are used indifferently." *Underwear and Hosiery:* Inch. *Shoes:* English sizes, French sizes.

Gloves: Inch. *Corsets:* Inch. "The importers usually sell all cloths, that is to say, men's cloths, by the yard. The retailers often and almost solely use the vara. The meter is used very little and for the most part only between importers and buyers at wholesale."

Measurement of Land: In agricultural districts: Caballeria, manzana, cuerda, fanega, almud. In smaller towns: Cuerda. In cities: Square vara.

Lumber and Timber: Foot and inch.

By Carpenters and Other Woodworkers: Foot and inch. *By Stone and Brick Masons:* Cubic yard, square vara, cuadrada. *By Tailors and Seamstresses:* Yard, vara.

In Blacksmith Shops: Libra, vara, meter. *In Machine Shops:* Foot and inch.

In Contracts for the Excavation of Ground: Cubic pie, cubic yard. *Mining and Mine Products:* English ton of 2000 lb. *Sizes of Pipe:* Inch.

Grain at Wholesale: Libra, quintal, fanega. *Meat at Wholesale:* Libra, arroba. *Root Crops at Wholesale:* Libra, quintal. *Coffee at Wholesale:* Libra, quintal. *Milk at Wholesale:* Liter, botella. *Butter and Cheese at Wholesale:* Libra. *Rubber at Wholesale:* Libra, quintal.

Railway Tariff: Passengers per mile, freight per pound per mile. *Urban Trucking:* Mile. *Railway Track Gage:* 3 ft.

"The artisans of the country use in their calculations the Spanish vara as the standard. Foreigners use the yard or the meter indifferently, but the lumber dealer and the dealer in logs sell by thousands of square feet (English)."

(Reply to a questionnaire sent out by Mr. Henry R. Towne)

Legal Standards: Metric.

Common Standards: Chiefly the old units. The people generally use the Spanish vara, the cuarta, and the libra.

Commercial Use: Metric system generally used in business.

Domestic Use: In domestic life the old Spanish measures are generally used.

Measuring Implements: Weighing scales are sold marked on one side in libras and on the other side in kilograms. Measures of length are marked on one side with the cuarta and on the other with the meter. Measures of volume comprise only the liter and the vara or cubic meter.

Dual Standards: The people continue to use the old Spanish measures from habit and because they know them better than the others.

Adoption of Metric System: The metric system was adopted here more than twenty years ago, when the Republic was established.

Bookkeeping, Invoicing, Etc.: The vara and the meter or yard are used indifferently.

"Our standard of weight is the quintal of 100 Spanish pounds. Our standard of measure is the botella."

According to the Report to the International High Commission on The Metric System in Export Trade, prepared by the Director of the Bureau of Standards, the metric system is "obligatory" in Guatemala.

Guatemala "adopted" the metric system in 1894.

HAITI

Factors in Foreign Trade, published by the Department of Commerce and Labor, 1912, gives the following information:

"*Weights and Measures:* Metric system, but pounds, tons and gallons are generally used in commerce and statistics. The pound of 500 grams (1.1023 pounds avoirdupois) is adopted in the customs; the ton is 2000 pounds; gallon is equivalent to United States gallon."

MEXICO

(Summary of ten returned questionnaires)

Groceries: Kilogram. *Fruits:* Kilogram. *Milk:* Liter, cuartillo. *Butter and Cheese:* Kilogram, pound. *Other Farm Products:* Kilogram, metric ton, arroba, carga, cuartillo. *Hardware:* Kilogram, meter, "as in U. S." *Fish:* Kilogram. *Meat:* Kilogram. *Flour:* Kilogram, arroba, carga. *Tea and Coffee:* Kilogram, libra, pound.

Dry Goods: Kilogram (*sic*), meter, centimeter, vara, yard.

Fuel: Kilogram, cord, quintal, metric ton, troje, zontla.

Tobacco: Kilogram.

Ready-made Clothing: Meter, yard, inch, centimeter, kilo (*sic*). "French and American indiscriminately." "As in U. S." *Hats:* Meter (*sic*), yard (*sic*), inch, centimeter. "French or American indiscriminately." "As in U. S." *Underwear and Hosiery;* Meter (*sic*), yard (*sic*), inch, centimeter. "French or American indiscriminately." "As in U. S."

Shoes: Meter (*sic*), yard (*sic*), centimeter, English sizes. "French or American indiscriminately." "As in U. S." *Corsets:* Meter (*sic*), yard (*sic*), centimeter, inch. "French or American indiscriminately." "As in U. S." *Gloves:* Meter (*sic*), yard (*sic*), inch, centimeter. "French or American indiscriminately." "As in U. S." "If material is from France, the meter; if from the United States, the yard."

For the Measurement of Land: In the farming districts: Hectoliter (*sic*), liter (*sic*), hectare, sitio, caballeria, acre, kilometer. In the smaller towns: Hectoliter (*sic*), liter (*sic*), hectare, square meter, acre, kilometer. In cities: Hectoliter (*sic*), liter (*sic*), hectare, meter, square meter, acre, kilometer.

Lumber and Timber: Foot, inch, cubic foot, meter, centimeter, pulgada, pie, kilogram (*sic*).

By Carpenters and Other Woodworkers: Foot, inch, meter, centimeter, pulgada, pie. *By Tailors and Seamstresses:* Meter, centimeter, vara. *By Blacksmiths:* Metric. *By Stone and Brick Masons:* Foot, inch, meter, square meter, kilogram, centimeter.

In Machine Shops: Inch, kilogram, meter, centimeter.

In Contracts for Excavation of Ground: Cubic meter, square meter, meter. *In Mines and for Mining Products:* Cubic yard, metric ton, square meter, kilogram, onza, meter. *In Smelting and for Smelter Products:* Foot, meter, metric ton. *Sizes of Pipes for Gas, Water, Sewers, Etc.:* Foot, inch, meter, centimeter.

In Ship and Boat Building: Meter, foot, kilogram. *Marine Measurements:* League, nautical mile, cubic meter, metric ton.

Hay at Wholesale: Kilogram, ton, arroba, metric ton. *Grain at Wholesale:* Quintal, kilogram, hectoliter, carga, cuartillo. *Meat at Wholesale:* Kilogram. *Root Crops at Wholesale:* Kilogram, quintal. *Coffee at Wholesale:* Quintal, kilogram. *Milk at Wholesale:* Liter, cuartillo, gallon. *Butter and Cheese at Wholesale:* Kilogram, pound (probably libra). *Garden Products at Wholesale:* Kilogram, quintal. *Rubber at Wholesale:* Pound (probably libra), kilogram.

Railway Tariff for Passengers and Freight (Load and Distance): Kilogram, kilometer, metric ton, cubic meter, mile, ton. *Loads and Rates for City Transportation:* Kilogram, kilometer, carga. *Loads and Rates for Transportation by Muleback Across the Mountains:* Carga, arroba, kilogram, kilometer. "The old weight (1 carga = 300 libras) still holds its own when dealing with muleback transportation." *Railway Track Gages and Length of Lines:* Kilometer, centimeter, foot, inch. *Railway Equipment (units used in the construction and repairing of locomotives, coaches, etc.):* Foot, inch, metric kilogram (*sic*). "As in U. S." "All transportation here is done by boat on a long-ton basis."

"In many cases the Spanish weights are used." "In many cases the libra and vara are used."

According to the Report to the International High Commission on The Metric System in Export Trade, prepared by the Director of the Bureau of Standards, the metric system is "obligatory" in Mexico.

Mexico "adopted" the metric system in 1862.

NICARAGUA

(Summary of three returned questionnaires)

Groceries: Libra, kilogram. *Milk:* Liter, gallon, botella (⅕ gallon). *Butter and Cheese:* Libra, arroba. *Other Farm Products:* Libra, quintal, fanega. *Hardware:* Libra, kilogram. *Fish:* Libra. *Meat:* Libra. *Flour:* Libra, kilogram. *Tea and Coffee:* Libra, quintal.

Dry Goods: Vara, yard, meter.

Fuel: Libra, corcada, marco, cordal, cuartillo.

Tobacco: Libra.

Ready-made Clothing: Inch, centimeter. *Hats:* "English and metric system." *Collars:* "English and metric system." *Underwear and Hosiery:* "English and metric system." *Shoes:* Centimeter. *Gloves:* "The measure of the country of origin." *Corsets:* "The measure of the country of origin."

For the Measurement of Land: In the farming districts: Manzana, hectare, vara, meter. In the smaller towns. Manzana, hectare, vara, meter. In cities: Manzana, vara, cuadra, meter.

Lumber and Timber: Vara, pulgada.

By Carpenters and Other Woodworkers: Vara, pulgada, tonelada (*sic*). *By Stone and Brick Masons:* Vara, pulgada, tonelada (*sic*). *By Tailors and Seamstresses:* Vara, centimeter, yard, meter.

In Machine Shops: Inch, centimeter, vara.

In Contracts for Excavation of Ground: Vara. *In Mines and for Mining Products:* "English system," tonelada. *In Smelting and for Smelter Products:* "English system." *Sizes of Pipe for Gas, Water, Sewers, Etc.:* Inch, pulgada.

Grain at Wholesale: Libra, fanega. *Meat at Wholesale:* Arroba, libra, kilogram. *Root Crops at Wholesale:* Quintal. *Coffee at Wholesale:* Libra, quintal. *Milk at Wholesale:* "Cantaro, of about 5 gallons." *Butter and Cheese at Wholesale:* Libra, kilogram. *Rubber at Wholesale:* Libra, quintal.

Railway Tariff for Passengers and Freight (Load and Distance): Kilogram, kilometer. *Loads and Rates for City Transportation:* Kilogram. *Loads and Rates for Transportation by Muleback Across the Mountains:* Libra. *Railway Track Gages and Length of Lines:* Gage, foot, inch; length, kilometer. *Railway Equipment* (*units used in the construction and repairing of locomotives, cars, etc.*): "All American."

"The metric system of weights and measures is the official and lawful system of the Republic, but owing to the preponderance of trade with the United States, the influences of the system obtaining there are felt in all commercial transactions." "The introduction of all imports is, however, based on the kilo, but throughout the Republic articles are retailed by the libra. Liquids when imported are measured by the liter, yet the American gallon or quart is commonly known. Distances are computed in kilometers, but the yard of 36 inches is used almost as much as the vara of 33 inches or the meter of 39.37 inches. So it might be said that the English system is almost as common as the metric."

The report of Mr. W. A. Graham Clark, Commercial Agent of the Department of Commerce and Labor, Part I, published by the Department in 1909, contains the

following: The 24-inch manta retails at 40 centavos a vara. The turkey-red shirting is mainly from England, retailing at 80 centavos a vara. The usual price of a 24-inch print is 60 centavos a vara."

According to the Report to the International High Commission on The Metric System in Export Trade, prepared by the Director of the Bureau of Standards, the metric system is "obligatory" in Nicaragua.

PANAMA

(Summary of five returned questionnaires. In view of the quotation below, libra has been uniformly interpreted as pound)

Groceries: Pound, ounce. *Fruits:* Pound, ounce. *Milk:* Quart, botella. *Butter and Cheese:* Pound, ounce. *Other Farm Products:* Pound, English quintal. *Hardware:* Pound, English quintal. *Fish:* Pound, English quintal. *Meat:* Pound, English quintal. *Flour:* Pound, English quintal, "barrel of 196 pounds." *Tea and Coffee:* Pound, ounce, English quintal.

Dry Goods: Yard, vara. *Fuel:* Long ton, short ton, English quintal, cord.

Tobacco: Pound, ounce, English quintal.

Ready-made Clothing: Hats: Collars: Underwear and Hosiery: Shoes: Gloves: Corsets: Inch, metric. "The articles mentioned are imported almost exclusively from the United States and the measures are the same as in that country." "A few French articles are metric sizes."

For the Measurement of Land: In the farming districts: Hectare, square meter. In the smaller towns: Hectare, square meter. In cities: Square meter.

Lumber and Timber: Inch, foot, square and cubic foot.

By Carpenters and Other Woodworkers: Inch, "some centimeters." *By Stone and Brick Masons:* Inch, centimeter, "American generally." *By Tailors and Dressmakers:* Yard, inch, centimeter, "American generally."

In Machine Shops: Inch, centimeter, pound, English quintal.

In Contracts for Excavation of Ground: Cubic meter, yard. *Sizes of Pipe for Gas, Water, Sewers, Etc.:* Inch.

In Ship and Boat Building: Inch, centimeter. *Marine Measurement:* Short ton, ton of 40 cu. ft., marine mile.

Hay at Wholesale: Pound. *Grain at Wholesale:* Pound, English quintal. *Meat at Wholesale:* Pound, English quintal. *Root Crops at Wholesale:* Pound. *Coffee at Wholesale:* Pound, English quintal. *Milk at Wholesale:* Quart, botella, gallon. *Butter and Cheese at Wholesale:* Pound. *Garden Products at Wholesale:* Pound, English quintal. *Rubber at Wholesale:* Pound,

Railway Tariff for Passengers and Freight (Load and Distance): Mile, pound, cubic foot. *Loads and Rates for City Transportation:* Pound. *Railway Track Gages and Length of Lines:* Inch, mile. *Railway Equipment (units used in the construction and repairing of locomotives, cars, etc.):* Inch.

"The Spanish units are never used here and while the metric system is the official standard for the country, with the exception of lands, it is seldom used in Panama, American (English) standards of weight and measure being in universal use."

Panama "adopted" the metric system in 1857.

PERU

(Summary of seven returned questionnaires)

Groceries: Kilogram. *Milk:* Liter, botella of 0.75 liter. *Butter and Cheese:* Libra, kilogram. *Other Farm Products:* Libra, kilogram. *Hardware:* Libra, pie. *Fish:*

Kilogram, libra. *Meat:* Kilogram, libra. *Flour:* Kilogram, libra. *Tea and Coffee:* Kilogram, libra.

Dry Goods: Meter, vara.

Fuel: Kilogram, quintal, libra.

Tobacco: Kilogram. (Government monopoly.)

Ready-made Clothing: Centimeter. *Hats:* Centimeter, "English numbers." *Collars:* Centimeter. *Underwear and Hosiery:* Centimeter, "Special measure." *Shoes:* Centimeter, "Special measure." *Gloves:* Centimeter, "Special measure." *Corsets:* Centimeter.

For the Measurement of Land: In the farming districts: Fanegada, topo, cuadra, square vara; "Sale and registry by the fanegada." In the smaller towns: Square meter, fanegada, topo, cuadra; "Sale and registry by the fanegada." In cities: Square meter, square vara, fanegada; "Sale and registry by the fanegada."

Lumber and Timber: Foot, inch, square foot; "Spanish foot for cedar."

By Carpenters and Other Woodworkers: Foot, inch, square foot, meter, "English system." *By Stone and Brick Masons:* Meter, square meter, arroba. *By Tailors and Seamstresses:* Centimeter, meter, yard.

In Machine Shops: Meter, inch, foot, quintal. "English system chiefly. A few jobs for European-built machinery are handled on the metric system."

In Contracts for Excavation of Ground: Cubic meter. *In Mines and for Mining Products:* Tonelada, metric ton, cubic meter, gallon of 3¾ liters for petroleum products. "Marco, a weight per cajon of 12,000 marcos. Troy ounces per ton. Grams per metric ton." "Spanish, English and metric." *In Smelting and for Smelter Products:* Kilogram, libra, foot. "The same as mining." *Sizes of Pipe for Gas, Water, Sewers, Etc.:* Meter, foot, inch, "Generally English feet and inches and their fractions."

In Ship and Boat Building: Meter, foot, inch, kilogram, registered ton. "Generally the English measures." *Marine Measurements:* Mile, ton, cubic meter, knot, braza (fathom of 6 English feet), metric ton. "Generally the English measures."

Hay at Wholesale: Quintal, metric quintal. *Grain at Wholesale:* Quintal, fanega, metric quintal. *Meat at Wholesale:* Kilogram, metric quintal, libra. *Root Crops at Wholesale:* Quintal, metric quintal, libra. *Coffee at Wholesale:* Quintal, libra. *Milk at Wholesale:* Liter. *Butter and Cheese at Wholesale:* Quintal, kilogram, libra. *Garden Products at Wholesale:* Arroba. *Rubber at Wholesale:* Tonelada, kilogram, quintal.

Railway Tariff for Passengers and Freight (Load and Distance): Kilometer, quintal, metric ton, cubic meter. *Loads and Rates for City Transportation:* Metric ton, kilogram. *Loads and Rates for Transportation by Muleback Across the Mountains:* Quintal, per kilometer. *Railway Track Gages and Length of Lines:* Meter, kilometer. *Railway Equipment (units used in the construction and repairing of locomotives, cars, etc.):* Meter, foot, inch, tonelada, kilogram.

"At the present time there are many who buy and sell, using other measures which are not metric decimal." "The metric system is the legal system in Peru but the other measures named have not yet been banished."

Commerce Reports for April 29, 1918, contains a report from Commercial Attaché W. F. Montavon, of Lima, in which are given particulars of new Peruvian exports duties. The new rates provide for a duty on copper bars per *short ton*, and on sugar, cotton and wool per *Spanish quintal*. Italicized words are verbatim from the report.

The report of Mr. W. A. Graham Clark, Commercial Agent of the Department of Commerce and Labor, Part IV, published by the Department in 1911, contains the following: "The Peruvian importers buy cotton goods by the yard, the meter, or the

vara. . . . Although the country has officially adopted the metric system, cloth is always retailed by the vara."

According to the Report to the International High Commission on the Metric System in Export Trade, prepared by the Director of the Bureau of Standards, the metric system is "obligatory" in Peru.

Peru "adopted" the metric system in 1862.

PORTO RICO

In 1913, Mr. F. S. Holbrook, Associate Physicist at the Bureau of Standards, went to Porto Rico as the representative of the Bureau to coöperate with the local legislature in connection with weights and measures legislation. Mr. Holbrook's report of his investigations contains the following: "This, then, was the condition of affairs when the work was commenced: The kilogram, the United States pound and the Spanish libra or pound for weight; the liter, the quart, the cuartillo for liquid measure; the meter, the yard and the vara for length measure; the hectare, the acre and cuerda for land measure, were all in use side by side. A little over 50 per cent. of the weights found in use were of the Spanish system, the remainder being about equally divided between weights of the metric system and of our customary system. Of the liquid measures tested, the very great majority were cuartillos or subdivisions thereof."

As the outgrowth of Mr. Holbrook's visit to Porto Rico the weights and measures of the United States, with the exception of the bushel and its subdivisions, were placed "upon an equal basis" with the metric units, the result being shown in the following reply to a questionnaire sent out by Mr. Henry R. Towne.

Legal Standards: Metric, U. S., and a few Spanish.

Common Standards: Metric, U. S., and some Spanish.

Railroad Distances: Kilometers.

Weights: Generally pounds, but also kilos.

Volume: Liter, Spanish quart, but generally U. S. quart.

Land: Spanish cuerda and metric hectare, the latter in deeds.

Cubic Meter: Used in public contracts.

Commercial Use: Commercial transactions on U. S. basis; Government transactions on metric basis.

Domestic Use: U. S. standards in common use and are legal. Metric catalogs of no use.

Measuring Implements: Both U. S. and metric in common use.

Dual Standards: Old Spanish measures generally displaced by U. S. measures, except the "cuerda" for land records. Metric system also legal; chiefly used in Government transactions.

Adoption of Metric System: By Spanish Government in early 90's. By local legislature in 1898. U. S. Standards also legalized since latter date.

Bookkeeping, Invoicing, Etc.: U. S. Standards used almost exclusively.

The William J. Dines, Jr., Co. write: "I have been with engineers and workmen in all parts of the Island, and very seldom find anyone using anything but the American standard."

The report of Mr. Wm. A. Graham Clark, Commercial Agent of the Department of Commerce and Labor, Part IV, published by the Department in 1911, contains the following: "In San Juan most goods are retailed by the yard as the people there demand this length, but in the remainder of the island the usual measure is the Spanish vara of 83.6 centimeters."

All of the above should be compared with the statement by Mr. Fred R. Drake as quoted on page 130.

SAN SALVADOR

(Summary of one returned questionnaire)

Groceries: Almud. *Milk:* Liter. *Butter and Cheese:* Libra. *Other Farm Products:* Libra. *Hardware:* Pound, quintal. *Fish:* Libra. *Meat:* Libra. *Flour:* Bulto. *Tea and Coffee:* Libra.

Dry Goods: Vara.

Fuel: Carga.

Collars: English numbers.

For the Measurement of Land: In the farming districts; Manzana, caballeria. In the smaller towns: Vara, "with metric measures always used in the documents." In cities: Meter and millimeter (*sic*).

By Stone and Brick Masons: Vara, pie, pulgada. *By Tailors and Seamstresses:* Vara, meter, millimeter.

In Contracts for Excavation of Ground: Cubic meter. *Sizes of Pipe for Gas, Water, Sewers, Etc.:* Inch.

Grain at Wholesale: Fanega, arroba. *Meat at Wholesale:* Libra. *Coffee at Wholesale:* Quintal. *Milk at Wholesale:* Botella. *Butter and Cheese at Wholesale:* Libra.

Railway Tariff for Passengers and Freight (Load and Distance): Cubic foot, quintal, kilometer. *Loads and Rates for City Transportation:* Quintal. *Loads and Rates for Transportation by Muleback Across the Mountains:* Arroba.

The report of Mr. W. A. Graham Clark, Commercial Agent of the Department of Commerce and Labor, Part I, published by the Department in 1909, contains the following: "Practically all exported yarn is put up in either five- or ten-pound paper-covered packets and either eighty or forty of these packed to the bale. Yarn is retailed here in ten-pound lots, but two five-pound packets are preferred to one ten-pound. . . . These splits are 20 to 26 inches wide, and retail at a real a vara."

SPANISH HONDURAS

(Summary of three returned questionnaires)

Groceries: Pound, arroba. *Fruits:* Pound. *Milk:* Liter, bottella, pint. *Butter and Cheese:* Libra, pound. *Other Farm Products:* Pound. *Hardware:* Pound. *Fish:* Libra, pound. *Meat:* Libra, pound. *Flour:* Libra, pound. *Tea and Coffee:* Libra, pound.

Dry Goods: Vara, yard.

Fuel: Carga, pound, cuerda.

Tobacco: Libra, pound.

Ready-made Clothing: Inch, "Same as in United States." *Hats:* "American and French sizes." *Collars:* "American and French sizes." *Underwear and Hosiery:* "American and French sizes." *Shoes:* "American and French sizes." *Gloves:* "American and French sizes." *Corsets:* "American and French sizes." "General American sizes of wearing apparel in use."

For the Measurement of Land: In the farming districts: Caballeria, manzana, hectare. In the smaller towns: Caballeria, manzana, hectare, foot. In cities: Clabaeria, manzana, hectare, foot. "The official standard is the hectare. Deeds in hectares and others in manzanas according to original measure. In towns the lots are measured in English feet and are so registered. Also large parcels in the country measured in caballerias."

Lumber and Timber: Laufenberg rule, "Exactly the same as American sizes."

By Carpenters and Other Woodworkers: Foot, inch. *By Stone and Brick Masons:* Inch, "American sizes." *By Tailors and Seamstresses:* Metric, foot.

In Machine Shops: Inch, foot, pound, "American sizes."

In Contracts for Excavation of Ground: Foot, inch, "American sizes." *In Mines and for Mining Products:* Cubic foot, ton, metric ton, "American sizes." *In Smelting and for Smelter Products:* Pound, ton, "American sizes." *Sizes of Pipe for Gas, Water, Sewers, etc.:* "Generally American sizes."

In Ship and Boat Building: "Same as in United States." *Marine Measurements:* Foot, "American sizes."

Hay at Wholesale: Libra. *Grain at Wholesale:* Carga, libra, medida. *Meat at Wholesale:* Libra, pound. *Root Crops at Wholesale:* Pound. *Coffee at Wholesale:* Carga, libra. *Milk at Wholesale:* Liter. *Butter and Cheese at Wholesale:* English arroba, libriado. *Garden Products at Wholesale:* Libra, pound. *Rubber at Wholesale:* Pound, libra, quintal.

Railway Tariff for Passengers and Freight (Load and Distance): Kilogram, kilometer, mile. *Loads and Rates for Transportation by Muleback Across the Mountains:* Arroba, pound. *Railway Track Gages and Length of Lines:* Foot, inch, kilometer. *Railway Equipment (units used in the construction and repairing of locomotives, cars, etc.):* "English units used in repairs."

"The English yard is chiefly used in the larger and better stores. The vara is used frequently in smaller stores selling at retail to certain classes, but the people are accustomed to and demand the English yard." "All articles not named above are valued according to agreement per arroba or carga, always keeping the English as the standard. The arroba is 25 pounds and the carga is 8 arrobas or 200 pounds."

The report of Mr. W. A. Graham Clark, Commercial Agent of the Department of Commerce and Labor, Part I, published by the Department in 1909, contains the following: "The importers sell to the retailers by the yard and the retailers sell at practically the same price by the vara . . . This country has officially tried to adopt the metric system, but the natives cling to the vara and the arroba as their measures of length and weight."

According to the Report to the International High Commission on the Metric System in Export Trade, prepared by the Director of the Bureau of Standards, the metric system is "obligatory" in Spanish Honduras.

URUGUAY

(Summary of four returned questionnaires)

Groceries: Kilogram. *Milk:* Liter. *Butter and Cheese:* Kilogram. *Other Farm Products:* Kilogram. *Hardware:* Kilogram, meter. *Meat:* Kilogram. *Flour:* Kilogram. *Tea and Coffee:* Kilogram.

Dry Goods: Meter.

Fuel: Metric ton.

Tobacco: Kilogram.

Ready-made Clothing: Centimeter. *Hats:* Centimeter, English numbers. *Collars:* Centimeter. *Underwear and Hosiery:* Meter, centimeter, inch. *Gloves:* "As in North America." "Universal numbering." *Corsets:* Centimeter.

For the Measurement of Land: In the farming districts: Hectare. "The cuadra is still commonly used but is prohibited in the documents." In the smaller towns: Hectare, square meter. In cities: Hectare, square meter.

Lumber and Timber: Meter, centimeter, foot, inch. "Officially the meter, customarily per thousand feet."

By Carpenters and Other Woodworkers: Meter, centimeter, English foot, inch. "English foot and inch generally used." *By Tailors and Seamstresses:* Centimeter,

kilo (*sic*), English measures. *By Stone and Brick Masons:* Kilogram, meter, metric ton.

In Machine Shops: Kilogram. "Officially the meter and sub-multiples, practically, following the custom, the English inch." "English measures generally."

In Contracts for Excavation of Ground: Cubic meter, meter. *In Mines and for Mining Products:* Kilogram, cubic meter. *In Smelting and for Smelter Products:* Kilogram, metric ton. *Sizes of Pipe for Gas, Water, Sewers, Etc.:* "English measures, but in official and public documents these are reduced to centimeters." "Officially the meter, practically the pulgada."

In Ship and Boat Building: Metric. *Marine Measurements:* Mile, knot, foot, cable, ton, meter for sounding, braza, "but in official and public documents only the decimal measures appear." "Officially the kilometer; to a large extent the marine mile." "In practice there is no effort to abolish completely the English measures."

Hay at Wholesale: Kilogram, metric quintal. *Grain at Wholesale:* Kilogram, metric quintal.

Meat at Wholesale: Kilogram. *Root Crops at Wholesale:* Metric quintal. *Coffee at Wholesale:* Kilogram, metric quintal. *Milk at Wholesale:* Liter, hectoliter. *Butter and Cheese at Wholesale:* Kilogram. *Rubber at Wholesale:* Kilogram.

Railway Tariff for Passengers and Freight (Load and Distance): Kilogram, kilometer. *Railway Track Gages and Length of Lines:* Metric.

"The metric system only has been used in Uruguay for at least fifty years and any one who uses any other system runs the risk of fine and imprisonment. . . . In the case of land measurement, a few old Spanish measures are authorized. This letter, according to the laws of Uruguay, must be copied in a letter-press book. Each page of the letter-press book is signed by one of the judges of the Commerce Court and may at any time be required in Court. By using in our correspondence copied in the letter-press book any terms of weights and measures not recognized by law, we run the risk of punishment." "The introduction of the new system proved, however, a difficult and tedious process."

According to the Report to the International High Commission on The Metric System in Export Trade, prepared by the Director of the Bureau of Standards, the metric system is "obligatory" in Uruguay.

Uruguay "adopted" the metric system in 1862.

VENEZUELA

(Summary of five returned questionnaires)

Groceries: Libra, kilogram. *Fruits:* Kilogram, libra. *Milk:* "Jar of 27 botellas," liter. *Butter and Cheese:* Libra, kilogram. *Other Farm Products:* Libra, metric. *Hardware:* Libra, metric. *Fish:* Libra, kilogram. *Meat:* Libra, kilogram. *Flour:* Libra, kilogram, arroba. *Tea and Coffee:* Libra, kilogram.

Dry Goods: Vara, meter, yard.

Fuel: Tonelada, metric ton.

Tobacco: Metric.

Ready-made Clothing: Inch, centimeter. *Hats:* Centimeter, inch. *Collars:* Centimeter, inch. *Underwear and Hosiery:* Centimeter, inch. *Shoes:* Centimeter, American numbers, "An arbitrary measure equal to about ¾ of a centimeter." *Gloves:* French numbers, American numbers. *Corsets:* Centimeter, inch. "The measures of the country from which the goods are imported are used."

For the Measurement of Land: Hectare, square kilometer, square league, sugar land in bablon (= 0.7 hectare), square meter.

Lumber and Timber: Square pie, metric.

By Carpenters and Other Woodworkers: Square pie, metric. "Some carpenters do actually work in English inches." *By Tailors and Seamstresses:* Centimeter, vara, yard, meter. *By Stone and Brick Masons:* Metric, fanega.

In Machine Shops: Libra, foot, metric.

In Contracts for Excavation of Ground: Metric. *In Mines and for Mining Products:* Metric. *In Smelting and for Smelter Products:* Metric. *Sizes of Pipe for Gas, Water, Sewers, Etc.:* Inch, metric.

In Ship and Boat Building: Metric, English. *Marine Measurements:* Metric English. "In navigation and geography miles are used; for the rest, metric."

Hay at Wholesale: Metric. *Grain at Wholesale:* Kilogram, metric quintal, fanega. *Meat at Wholesale:* Arroba, metric. *Root Crops at Wholesale:* Metric. *Coffee at Wholesale:* Metric quintal. *Milk, Butter and Cheese at Wholesale:* Metric.

Railway Tariff for Passengers and Freight (Load and Distance): Metric quintal, tonelada, kilometer, cubic meter. *Loads and Rates for City Transportation:* Metric quintal, kilogram. *Loads and Rates for Transportation by Muleback Across the Mountains:* Metric quintal. *Railway Track Gages and Length of Lines:* Meter, kilometer. *Railway Equipment (units used in the construction and repairing of locomotives, cars, etc.):* "Inches on English lines; metric units on German railway."

"Not only is it illegal to use any other weights and measures [than those of the metric system], but a merchant is subject to punishment even for having them in his possession. The importation of weights and measures other than the legal is also prohibited and as the authorities have destroyed the old ones whereever possible distinct progress toward the universal adoption of the new system has been made. In spite of the stringency of the laws the people at large, especially in the country, still cling to the old units in their every-day life and talk and think in terms of them."

"The people in the interior of the country are not at all accustomed to the metric system and always use the old system."

Venezuela "adopted" the metric system in 1857.

APPENDIX TO CHAPTER II

FORM LETTER WHICH ACCOMPANIED THE QUESTIONNAIRES

MY DEAR SIR:

The American Institute of Weights and Measures, which is composed of many of the leading engineers and manufacturers of this country, is engaged in an extended investigation of the subject of weights and measures, and it desires to obtain at first hand definite information regarding the units of weight and measure (Spanish, metric, and English) as applied to the trade, commerce and industry of South and Central America. With this in view, the accompanying list of questions has been drawn up to which we ask you to kindly reply for your locality.

The thorough character of the investigation which this Institute is undertaking will, we hope, impress you with the importance of this questionnaire, since, when all the replies are assembled, they will constitute a mass of information which is not now in existence.

It is particularly desired that answers shall be forthcoming from the smaller towns of the interior as well as from the principal cities of Latin America AND FROM INDUSTRIES AS WELL AS COMMERCE in order that the usage of weights and measures among the people may be learned. To this end we ask you to kindly make inquiry among contractors, builders, manufacturers, and, if necessary, among artisans.

Please distinguish carefully, when necessary, between the metric and English tons, between the half-gilogram and the Spanish and English pounds, the Spanish and metric quintals, and the Spanish pulgada and the English inch. When two or more

units are used for the same purpose, please name them in the order of their frequency. When one unit is chiefly used, please place after it the word "Chiefly" and similarly, when one of the units is used but seldom, kindly place after it the word "Infrequent."

Your reply, esteemed sir, will place us under lasting obligations which we trust we will at some future time have the pleasure and satisfaction of discharging. In the meantime, we beg to subscribe ourselves with every consideration of respect and esteem,

Most cordially yours,

AMERICAN INSTITUTE OF WEIGHTS AND MEASURES,

..... *Commissioner.*

QUESTIONNAIRE NO. 1

What are the units of weight and measure commonly used with relation to the buying and selling at retail of the following products?

Groceries
Fruits
Milk, butter and cheese
Other farm products
Hardware
Fish
Meat
Flour
Tea and coffee
Dry goods
Fuel
Tobacco
Miscellaneous

QUESTIONNAIRE NO. 2

What are the units of measure commonly used with relation to buying and selling articles of clothing, as follows?

Ready-made clothing
Hats
Collars
Underwear and hosiery
Shoes
Gloves
Corsets
Miscellaneous

QUESTIONNAIRE NO. 3

What are the units of measure commonly used with relation to the sale of lands and filing of papers and deeds, as follows?

In the farming districts
In the smaller towns
In the cities

QUESTIONNAIRE NO. 4

What are the units of weight and measure commonly used in the following industries?

Lumber and timber (length and thickness of boards and sizes of timbers)
By carpenters and other woodworkers
By tailors and seamstresses
By blacksmiths
In machine shops
In contracts for excavation of ground
In mines and for mineral products

In smelting and for smelter products
Sizes of pipes for gas, water, sewers, etc.
In ship and boat building
Marine measurements (distances, maps, charts, tonnage, drafts, freight rates, etc.)

QUESTIONNAIRE NO. 5

What are the units of weight and measure commonly used with relation to the buying and selling of farm products at wholesale, as follows?

Hay
Grain
Meat
Root crops
Coffee
Milk, butter and cheese
Garden products
Rubber
Miscellaneous

QUESTIONNAIRE NO. 6

What are the units of weight and measure commonly used with relation to transportation tariffs?

Railway tariff for passengers and freight (load and distance)
Loads and rates for city transportation
Loads and rates for transportation by muleback across the mountains
Railway track gages and length of lines
Railway equipment (units used in the construction and repairing of locomotives, cars, etc.)

The Hill Publishing Company's questionnaire was considerably abbreviated from the above.

CHAPTER III

THE METRIC SYSTEM IN EXPORT TRADE

The renewal of the agitation for the adoption of the metric system, because of the speciously plausible assumption that it is necessary in the interest of foreign trade, has made necessary the investigation which is herein summarized.

This assumption is known to be untrue by manufacturers and others who are in touch with export trade. Those who are properly informed know perfectly well that our standard system of weights and measures is not, and never has been, an obstacle to the sale of our products abroad.

In normal times, we import large numbers of high-class French clocks, and, similarly, we export tens of thousands of cheap clocks to all parts of the world. It would be absurd for an American purchaser to object to a French clock because it was made to the metric system, and equally absurd to suppose that a foreign purchaser would object to our clocks because they are made to the English system. To come still nearer home, American watches are made to both the English and the metric systems, but not one watch owner in a thousand knows or cares to which system his watch was made. You, gentle reader, do not know and never gave the matter a thought.

Again, in former days, when France led in the automobile industry, large numbers—for those days—of French machines were imported into this country regardless of the fact that they were made to the metric system. Today the situation is reversed. The American automobile industry has conquered the markets of the world, its products selling in metric and non-metric countries alike and regardless of the fact that they are made to the English system.

In the broader view, in normal times we import vast quantities of goods from metric countries which we buy without thought or question of the units of measurement to which they are made. Just as metric countries give no thought to the adoption of the English system in order to sell goods to us, so there is no reason why we should consider adopting the metric system in order to sell goods to them.

These simple facts are known to all who have intelligent knowledge of export trade, for whom this work is one of supererogation. It is, however, to demonstrate these facts by a flood of evidence and for the benefit of the uniformed that this investigation has been made and this report prepared.

Herein is summarized the experience of 284 manufacturers who have been engaged in export trade for from 10 to 20 years, 225 from 20 to 40 years, 48 from 40 to 60 years, and 10 from 60 to 100 years and more. This experience includes that of not only the oldest, but also the largest of our manufacturing corporations, the names of some of which are known throughout the civilized world.

One of those whose report is here included, has been engaged in export trade for "over a century," another for 107, and another for 135 years without finding any need for the adoption of the metric system, for the benefit of such trade. Plainly, the convenient assumptions of those who have no knowledge of, or contact with, export trade but who do have a case on their hands to prove, count for nothing in the face of the experience of such a list of those who are actually engaged in such trade.

In view of the thoroughness of the inquiry, this report may fairly be regarded as a census of the use of the metric system in this country.

The inquiry took the form of a questionnaire, which was sent to the following lists of manufacturers:

1. The members of the American Institute of Weights and Measures, of whom many are exporters.

2. The members of the American Manufacturers Export Association.

3. Those included in a card list of exporting manufacturers compiled by the American Manufacturers Export Association.

The total number of those to whom questionnaires were sent exceeded 6,000. No selections were made from these lists, the questionnaire being sent to every name upon them. The number of countable replies received was 1,445.

The promise of a copy of our report to each one who answered the questionnaire (see Form Letter No. 1 below) brought many replies from those who added to their questionnaires that they did no export business, or that their export business was confined to English speaking countries. Such questionnaires, having no significance, were not counted.[1]

A considerable number of replies were received, filled out in due and proper form, except that they were unsigned. Such questionnaires were not counted, except that unsigned questionnaires enclosed with signed letters or in envelopes carrying printed firm or corporate names and addresses were counted.

A few replies were received from exporting merchants but, since it is physically impossible for a merchant to record on one sheet the practice in producing the numerous products in which he deals, such replies were not counted. This was foreseen and provided for in the first paragraph

[1] From the standpoint of *export trade*, as distinguished from *export trade with metric countries*, these latter replies (which, of course, show no use of the metric system) should have been counted. The metricites in their enthusiasm for their hobby, forget that their argument for the adoption of the metric system to facilitate trade with metric countries is an argument *against* it, for trade with other countries.

of Form Letter No. 1, by which the inquiry was restricted to exporting manufacturers.

The questionnaire was sent out with Form Letter No. 1. The questionnaire itself follows Form Letter No. 1.

Dear Sirs:

In accordance with the purpose of the Constitution of this Institute to investigate the usage of weights and measures in their various applications, we enclose to you, and to a large number of exporting American manufacturers, a questionnaire intended to discover at first hand how much truth there may be in the assertion that this country should adopt the metric system if it expects to succeed in the cultivation of foreign markets.

Such an inquiry is obviously a necessary preliminary to the proper consideration of a change in our fundamental units of weight and measure, but, until now, no effort has been made in any quarter to conduct one. You will, we are sure, agree that it is a matter of first importance and we believe you will be glad to assist us by filling out and returning the blanks of the questionnaire.

This questionnaire represents but a small part of the investigations which we have in progress, and your coöperation is of even greater importance than here appears.

In order that you may retain a copy for your files in convenient form, the blanks are enclosed in duplicate.

When completed and published a copy of our report will be forwarded to all who show interest by supplying the asked for data.

Please answer whether you do or do not use the metric system. We want the facts on both sides.

Form Letter No. 1

_____

_____—1917.

American Institute of Weights and Measures,
20 Vesey Street, New York.

Gentlemen:

Referring to your inquiry regarding our experience with weights and measures in foreign trade, you will find that experience summarized below:

We have been engaged in foreign trade for ..... years.

Our line of products consists of .....

In our factory work, and in order to adapt our goods to the needs of buyers in metric countries, we have found it desirable to abandon English measures and use, instead, metric measures for the various dimensions of our products to the following extent:

Not at all	
Slightly	
Considerably	
Extensively.	
Exclusively	

Make a cross in the appropriate square.

Exclusively is understood to mean the absence of all English dimensions in the product—not a few metric dimensions in every shipment.

Remarks and Particulars

We have found it advisable to pack our goods for trade with metric countries in containers of metric dimensions or containing metric weights to the following extent:

Not at all	
Slightly	
Considerably	
Extensively	
Exclusively	

Make a cross in the appropriate square.

Remarks and Particulars

In our literature for and correspondence with metric countries, we have found it advisable to give information regarding weights, output, capacities, over all dimensions, etc., in metric terms as follows:

Not at all	
Slightly	
Considerably	
Extensively	
Exclusively	

Make a cross in the appropriate square.

Remarks and Particulars

Yours very truly,
The Questionnaire.

THE FIRST QUESTION

In our factory work, and in order to adapt our goods to the needs of buyers in metric countries, we have found it desirable to abandon English measures and use, instead, metric measures for the various dimensions of our products to the following extent:

This question is by far the most important of the three. When a manufacturer makes his products to the millimeter to the exclusion of the inch, he has, in truth, adopted the metric system and until he does that, he has not adopted it. The giving of catalog information in metric terms is a use of the metric system, but a use exactly comparable with the use of the Spanish language in catalogs for Spanish America and is no more the adoption of the metric system than the printing of such catalogs is the adoption of the Spanish language.

The fact that the commercial use of weights and measures is before us in every business transaction of every-day life leads many, including substantially all of the metric party, to assume the commercial use to be of paramount importance, and, indeed, to ignore the factory use. When

we reflect that, excepting some food stuffs, substantially everything we buy is made before it is sold, that factory measurements largely outnumber (frequently 100 and sometimes 1000 to 1) those which appear in sales transactions, that commercial measurements are usually the roughest approximations while factory measurements are often of the highest degree of refinement by precision measuring instruments developed for that purpose, we find that the primary, important measurements of civilization are those made in the production of commodities.

In 19 cases returned questionnaires included different lines of products in the production of some of which the metric system is used and in others not. In some of these cases the fact was noted in the questionnaires, and in others it was brought out by Form Letter No. 2[1]. These 19 cases have been added to the summary of industries below, but not to the tabulated summary of the answers.

Replies to the first question are summarized in Table No. 1.

	Count of returns	Per cent.
Not at all	1189	82.3
Slightly	160	11.2
Considerably	29	2.0
Extensively	16	1.1
Exclusively	5	0.3
No reply to this question	46	3.1
Total	1445	100.00

TABLE 1.—SUMMARY OF REPLIES TO THE FIRST QUESTION

NO USE OF METRIC SYSTEM IN PRODUCTION

The following extracts from letters make a suitable introduction to this phase of the subject.

The American Printing Company (textiles) write:

"We have equipped some of our cloth folding machines to record meters instead of yards so that we can meet requirements for lengths in meters, but practically all our goods for export are measured in yards."

FORM LETTER NO. 2[1]

Gentlemen:

Referring to your returned questionnaire in which you say that you use the metric system "considerably" in the manufacture of your products, and give as your products ——, ——, ——, etc." I write to ask if your notation refers to all of these products, or to only a portion of them, and in the latter case, to which ones.

The American Rolling Mill Company (iron plates, sheets, and billets, in export trade 7 years) write:

"In many Latin markets, the English measurement system has been adopted for our line of goods by the majority of buyers."

The American Stove Company (stoves; in export trade "many" years) write:

"As to factory methods of measurement, we have made no change whatever in order to adapt our goods for export. All of our goods are made to English standards of measurement."

The Babcock Printing Press Manufacturing Company (printing machinery; in export trade 30 years) write:

"We consider the proposition of changing our system of weights and measures to the metric system as no more necessary or desirable than teaching the men in our shop the language of the country in which the machine is to be run."

The Berger Manufacturing Company (sheet metal products; in export trade 15 years) write:

"We find that customers [in metric countries] are invariably acquainted with our system and that they are able to make conversions into our weights and measures the same as we do when an inquiry comes to us in metric."

The Black-Clawson Company (paper mill machinery; in export trade 25 years) write:

"We have had no trouble whatever using English measures."

The Boston Pressed Metal Company (metal stampings; in export trade 10 years) write:

"France, Russia, Argentine, Brazil, Denmark, Australia and Canada use regular stock of inch sizes."

The Bristol Patent Leather Company (in export trade 12 years) write:

"The largest leather producing countries use the square foot as their basis. Therefore, the square foot is a familiar unit even in countries using the metric system."

F. W. Brody & Co. (cotton seed products, in export trade "many" years) who reply Not at All to all of our questions, add:

"And our exports the past season were approximately $1,000,000."

The Brown Folding Machine Company (paper folding machinery, in export trade 20 years) write:

"We cannot recall any instance where we have been asked to give anything but United States standard weights and measures."

The Brown Portable Conveying Machinery Co. (portable conveying machinery; in export trade 6 years) write:

'The foreign buyer buys from our standard sizes nearest to his approximate metric requirements."

The Collins Company (edge tools, in export trade 70 years) write:

"Our business is nine-tenths with foreign countries. We have no need whatever to use the metric system in our business."

The Cudahy Packing Company (packing-house products; in export trade for 30 years) write:

"We do an export business amounting to many million dollars per annum, but have not found it necessary to mark our goods with anything but the usual English weights."

The Cadillac Automobile Company write:

"We have been shipping automobiles abroad for 15 years and have never had the question of metric measurements raised by any of our correspondents or customers abroad."

Curtis and Marble Machine Company (cloth finishing machinery; in export trade 40 years) write:

"Where the goods are measured by the roll or drum system, we use the regular yard circumference drum and then use compensating gears to reduce this to meters. In the South American trade there are four or five different lengths used, none of them metric and each a specific measurement for individual countries."

The Benjamin Eastwood Company (textile machinery) write:

"There is no call for the metric system of weights and measures in building textile machinery for export. We have had many inquiries and cannot remember a single instance where the inquiry has specified that the machinery must be built under the metric system."

The Chase Turbine Manufacturing Company (wood working machinery; in export trade 40 years) write:

"One customer has a scale attached to the machine to indicate width of opening. This scale is graduated according to the metric system."

The William J. Dines, Jr. Company (plantation machinery; in export trade 6 years) write:

"When we receive orders for machinery, it is usual to receive a sketch showing the proposed installation and the dimensions are more often given in feet and inches than in the metric measures even from countries using the metric system.

The Dodge Steel Pulley Corporation (steel pulleys; in export trade 17 years) write:

"All made in English dimensions."

Eastman, Gardiner & Company (building lumber; in export trade 12 years) write:

"After the meeting of the National Foreign Trade Council last year during which meeting the matter of the metric system for foreign business was brought up, we took the matter up with our foreign agents in France, Belgium, Germany, Italy and England and asked them if there would be any advantage in our adopting the metric system in figuring lumber. They stated that although the metric system was used

in some of the above countries that in lumber, the buyers were so accustomed to using the English measure that it would be a great mistake to make any change in our method of figuring."

Fairbanks, Morse & Company write:

"We have been actively engaged in developing foreign trade for the past 15 years and our experience touches practically every country in the world. The lines of goods that we manufacture and sell abroad are quite varied, embracing internal combustion engines, steam, power, and centrifugal pumps, electrical dynamos and motors, railway supplies and windmills.

We are, of course, sending our goods to countries where the metric system is used, but we have not seen any necessity whatever for abandoning the English standard of weights and measures."

The Fawcus Machine Company (gears and gear drives: in export trade 16 years) write:

"On one occasion we made some special machinery to drawings furnished by a customer in Spain on which metric dimensions were used. We readily transcribed them into English."

The R. P. Hazzard Company (men's shoes; in export trade 10 years) write:

"We have never had called to our attention any metric system for designating sizes of boots and shoes."

The Hess Machine Works (file making machinery; in export trade 25 years) write:

"We have exported to all parts of the world where files are manufactured and we have never departed from the American standard."

The Independent Pneumatic Tool Company (portable pneumatic tools; in export trade 24 years) write:

"We have never used the metric system nor have we been asked to do so."

The Lauderdale Cotton Mills (colored cotton goods; in export trade 4 years and who place their cross in the Not at All line) write:

"Our entire output is being exported."

The Metals Specialties Company (metal specialties) write:

"We are shipping goods to all foreign countries and we do not use the metric system in any way whatsoever."

The National Radiator Company (steam radiators, boilers and fittings) write:

"Our foreign customers have taken our products just as we manufacture them for domestic trade."

The Penn Engineering Company (steam and water specialities, in export trade 18 years) write:

"We have never used anything except English measures, nor found any need to change at any time."

The Russell Burdsall & Ward Bolt & Nut Company (bolts, nuts, rivets and washers; in export trade 20 years) write:

"We ship our goods to almost every country throughout the world and find that the English weights, measures, etc., are generally satisfactory."

William Sellers & Company (machine tools and power transmission machinery; in export trade 60 years) write:

"Notwithstanding the large volume of foreign inquiry we receive, so little of it calls for adherence to the metric system as to be practically negligible."

The Southern States Lumber Company (long leaf yellow pine lumber, in export trade 19 years) write:

"Up to 18 or 20 years ago, our French buyers required their flooring boards to be measured in metrical feet[1] of 13⅛ English inches, but since then, English measures have prevailed in that market."

The Standard Sanitary Manufacturing Company (plumbing fixtures, in export trade 20 years) write:

"Our trade is using English dimensions more and more. Requisitions are now seldom written up in the metric system."

The Triumph Manufacturing Company (bakery machinery; in export trade 12 years) write:

"We find that while certain foreigners have been taught the metric system, they more readily adapt themselves to the English measures."

The Wheeler-Schebler Carburetor Company (carburetors) write:

"We have had no occasion to use the metric system in the manufacture of our products."

The Walter A. Wood Mowing and Reaping Machine Company, who reply Not at All to all of our questions, say:

"We do a large export trade in Scandinavia, France, Germany, Russia, Austria-Hungary and Roumania."

The Wellman-Seaver-Morgan Company (mining, hoisting, and vessel unloading machinery) write:

"We do not use the metric system in our shops, and have had practically no request to use it from our foreign customers."

Representatives of the following industries reply to the first question regarding the use of the metric system in the production of their goods for export by placing their crosses in the Not at All line. The figures in parentheses following each industry give the number of manufacturers so reporting.

The reader will note especially the number of chemical industries in this list which show that manufacturing, as distinguished from laboratory, chemistry is conducted on the English system. The numerous electrical industries which follow the English system show that the prevailing impression that the electrical is a metric industry is unfounded.

Many of the industries of this list, such as chemicals, agricultural

[1] This expression obviously refers to the foot of the old French system which has the value given.

machinery, mining machinery, etc., produce not one, but great lines of products. Such industries, however, appear as single items, the list being not one of products, but of industries.

If the reader will search this list for an industry of which the saleability of the product would be increased by the adoption of the metric system, his failure to find one will teach him more than all the arguments he can read.

Automobiles and automobile trucks (22). Automobile accessories (4). Air compressors (6). Agricultural implements (18). Agricultural and harvesting machinery (9). Automobile frames (2). Automobile greases (1). Automobile lamps (1). Automobile and wagon axles (1). Air brakes (2). Automobile soap (1). Automobile parts (2). Adding machines (5). Automobile radiators (1). Automobile and wagon springs (1). Anti-skid chains (1). Asphalt (1). Athletic goods (1). Asbestos (1). Abrasives (3). Animal and poultry remedies (1). Art metal goods (1). Aluminum goods (1). Addressing machines (1). Accounting devices (1). Artificial arms (1). Architectural terra-cotta (1). Aeroplanes (1). Ammunition (1). Air rifles (1). Atomizers (1). Air hoists (1).

Boots and shoes (21). Barbers' furniture and supplies (2). Brick making machinery (3). Bottle washing machines (2). Bottle blowing machines (1). Bottlers' machinery (2). Bottle wiring tools (1). Bottle labeling machines (1). Bedsteads, brass and iron (5). Boiler feed regulators (1). Boiler compounds (1). Bolts, nuts and rivets (4). Biscuits (2). Balls (2). Bending machines (1). Brake lining (2). Buttons (1). Button fastening machines (1). Ball bearings (1). Belt hooks and tools (2). Belt preservatives (1). Box strapping (1). Brazing compounds (1). Bronze bearings (1). Bags and canvas goods (2). Bicycles (1). Books (1). Boiler tubes (1). Bolt clippers (1). Bee-keepers' supplies (1). Bakery machinery (1). Braids (1). Belting (2). Brass and copper sheets, wire and other goods (6). Box shooks (1). Blankets (1). Boiler shop equipment (1). Blast furnace equipment (1).

Chains, including chain belting (6). Cutting tools (14). Carbon paper (3). Cranes (6). Confectionery (5). Conveying machinery (4). Carbureters (2). Cement machinery (3). Concrete machinery (8). Coal (6). Coke (4). Chemicals, including crude drugs (19). Cement including Portland, rubber and iron (8). Cordage, including twine (4). Cocoa and chocolate (2). Corsets and accessories (1). Cooperage (1). Cooperage material (1). Cooperage machinery (1). Clocks (2). Corn shellers (2). Copper (2). Cotton Waste (1). Cotton seed oil machinery (1). Centrifugals (1). Cream separators (1). Check protecting devices (1). Crockery (1). Carriages (1). Conduit for electric wires (1). Chewing gum (2). Currant cleaning

machines (1). Cars for railways (2). Cutlery (1). Cardboard (1). Coffee mills (1). Coal handling machinery (2). Culverts (1). Children's sleds (1). Clay working machinery (1). Catenary bridges (1). Cooking utensils (1). Crown corks (1). Chairs (1). Car wheels (2). Car axles (1). Creosoted timber products (1). Collapsible tubes (1). Contractors' machinery (2). Caseine (1). Cotton linters, waste (1). Candles and stearine (1). Cutting machines (1). Cotton gin machinery (1). Cigar and cigarette machinery (1). Confectionery machinery (1). Cash registers (1). Cotton seed products (1). Counting machines (2). Chemical wood pulp (1). Corduroy (1). Car couplers (1). Cotton duck (2). Conduit fillings (1). Coal mining machinery (1). Coaster brakes (1).

Dental furniture, equipment and supplies (5). Drop forgings (1). Dyeing machines (2). Dairy machinery (2). Dustless dusters (1). Disinfecting apparatus (1). Duplicating machines (1). Drawing tables (1). Doors and sash (2). Disinfectants (1). Druggists' labels (1). Dye stuffs and dyewood products (4). Drawing rolls (1).

Electric generators and motors (14). Electric controllers (2). Electric light supplies (3). Electric specialties (3). Electric industrial trucks (1). Electric furnaces (1). Electric pumps (1). Electric wiring devices (1). Electric wire cutters (1). Electric air compressors (1). Electric arc welding equipment (1). Electric dental engines (1). Electric vacuum cleaners (1). Electric heating devices (2). Electric signaling apparatus (1). Electric measuring instruments (2). Electric fans (2). Electric transformers (2). Electrical fuses (1). Electrical material (1). Electrical porcelain (1). Electrically driven tools (4). Electrodes (1). Enamelled physicians' furniture (1). Elevating machinery (1). Excavating machinery (1). Explosives (1). Envelopes (1). Etching material (1). Evaporated milk (1). Expanded metal reinforcements (1). Elevators (1). Embroidery and laces (1). Engineers' and surveyors' instruments (2). Enamelled ware (6).

Food products, including cereals, canned goods, packing-house, fruit and soup (24). Forging machines (2). Fans (2). Fibreboard (2). Firearms, sporting (4). Firearms, military (2). Flour (5). Feed (4). Flour mill machinery (1). Firebrick (3). Felt (2). Food choppers (1). Fire door fixtures (1). Feed mills (1). Feed and ensilage cutters (1). Filing cases (1). Fire apparatus (1). Fire alarm signals (1). Forges (1). Foundry equipment (2). Furnaces (3). Filters and filter presses (2). Flexible shafts (1). Fertilizer machinery (1). Flatirons (1). Fire resisting paints (1). Fibre conduit (1). Fare registers (1). Files and rasps (1). File making machinery (1). Feed water heaters (1). Floor and wall tile (1). Fireless cookers (1). Ferro alloys (1). Featherbone dress stays (1). Fly paper (1). Fuel economizers (1). Fermented liquors (2).

Grinding wheels (4). Grinding mills (1). Grinding wheel dressers (1). Gas, gasoline, and oil engines, large and small (12). Glass, including plate, window, table, bottles, etc. (8). Gasoline handling equipment (1). Gasoline lighting system (1). Gold milling machinery (1). Gun carriages (1). Glass enamelled apparatus (1). Gas producers (1). Gasoline locomotives (1). Gas water heaters (1). Gas burners (1). Gas and gasoline stoves (1). Gear wheels (3). Glue (2). Gaskets and packings (1). Gas meters (1). Gravity conveyors (1). Garters (3). Graphite (1). Geared hand brakes (1). Garbage receivers (1). Gelatine (1).

Hoisting machinery (2). Hosiery (10). Hosiery knitting machines (1). Horseshoes (2). Handles for shovels, etc. (2). Horseshoe calks (1). Hacksaw blades (1). Hydrants (1). Hot water heaters (1). Heeling boards (1). Heat insulating materials (1). Hammocks (1). Hospital furniture (1). Hospital supplies (1). Hydraulic turbines (2). High pressure hydraulic machinery (1). Hardware, including builders', carriage, upholstery, saddlery, marine and automobile (23).

Ice and refrigerating machinery (4). Ice cream freezers (2). Ice and roller skates (1). Industrial railroad tracks (1). Irrigation equipment (1). Insulating tape (1). Insulating materials (1). Incandescent mantles (1). Insulated wire (1). Injectors (1). Iron fencing (1). Ivory goods (1).

Jewelry (5). Jewellers' tools and machinery (2). Jewellers' supplies (1).

Knit goods (2). Knitting machine needles (1). Knitting machinery (1). Kitchen cabinets (2).

Lumber, building and cabinet (19). Leather, including upholstering, sole, patent, glazed kid, etc. (14). Leather goods (1). Leather machinery (2). Leather substitutes (1). Lubricating oils and greases (9). Lubricators and lubricating devices (4). Lifting jacks (2). Laundry machinery (3). Lawn mowers, hand, horse and power (2). Lead pencils and erasers (1). Lightning arrestors (1). Lithography (1). Lithographers' machinery (1). Locks (2). Logging machinery (1). Linoleum (1). Library and parlor tables (1). Lithopone (1). Licorice products (1). Locomotives (1). Lace curtains (1). Lead (1). Lead goods (1). Loose leaf books (2). Lockers, cabinets and shelving (1).

Machine tools (60). Machinists' chucks (4). Machinery, type not specified (18). Musical instruments (4). Marine engines and motors (4). Mining machinery (10). Metal packing (1). Mine shoveling machines (1). Malleable iron castings (1). Metal wheels (1). Mixers (1). Metal mouldings (1). Metal stampings (1). Metal cutting saws (1). Motor boats (1). Machine screws (1). Marine paints (1). Macaroni (1). Meters (1). Metal casement windows (1). Metals and by-products (2). Motorcycles (1). Malt (1). Magnetos (1).

Manganese steel castings (1). Mower knives and sections (1). Medicinal preparations (1). Mercerizing machines (1). Medicine cabinets (1). Metallurgical machinery (1). Mosquito netting (2). Motion picture films (1).

Nails (2). Nickel ware (1).

Office filing equipment (2). Oil mill machinery (1). Oil well machinery (1). Oil well supplies (2). Oil cake (1). Oil burning utensils (1). Oil cloth (1). Oxy-acetylene apparatus (1). Optical goods (5). Optical machinery (1). Oil measuring pumps and tanks (1). Oiled clothing (1).

Pumps, including hand, power, centrifugal, steam and pumping engines (19). Paper of all kinds (13). Petroleum products (7). Power transmission machinery (8). Paints, oils, varnishes and enamels (13). Pianos and player-pianos (4). Pipe, including drawn and cast iron (8). Pipe fittings (including the Crane Company. Why do they not take their own medicine instead of urging it upon others?) (4). Pipe machinery (4). Pipe wrenches (1). Pig iron (3). Presses, mechanical (2). Printing presses and other printing machinery (6). Printing furniture (1). Picture frames and mouldings (2). Pulleys, cast iron and steel (3). Punching and shearing machines (2). Phonographs and graphaphones (2). Pneumatic tools (2). Paste and polish (2). Plumbing brass goods (1). Pulverizing machinery (1). Plumbing fixtures (1). Propellers and marine specialties (1). Pads for horses (1). Power hammers (2). Plaster of Paris (1). Precious metals (1). Plantation machinery (1). Pottery (1). Plumbers' earthenware (1). Paper boxes (2). Paper mill machinery (5). Paper hangers' tools (1). Paper merchandise (1). Painters' tools and supplies (1). Pharmaceutical and proprietary medicines (3). Pharmaceutical machinery (1). Padlocks (1) Pulp mill machinery (1). Pile drivers (1). Positive pressure blowers (1).

Quarry and gravel pit machinery (2).

Rubber goods, including automobile tires, belting, heels, footwear, etc. (11). Rolling mill machinery (4). Rock crushing machinery (3). Rock drills (2). Railway track material (2). Refrigerator doors (2). Rubber mill machinery (1). Railway signaling apparatus (1). Railway and contractors' tools (1). Railway passenger coach fixtures (1). Railway accessories (1). Razors (1). Rawhide gears (1). Refrigerators (1). Radium, vanadium and uranium (1). Rice milling (1). Radiators for automobiles (1). Rotary surface grinders (1). Roofing paints (1). Roofing tiles (1). Recording instruments (1). Rug extractors (1). Razor strops (1). Railway supplies (2). Road scrapers (1). Railway motor cars (1). Rolling store ladders (1). Road machinery (2). Roofing materials (1). Rare metals (1). Ratchet drills (1).

Steel and iron products, including billets, sheets, plates, structural

steel, castings, blooms, bars, etc, (31). Steam engine governors (2). Steam specialties (4). Shoe machinery (3). Shoe material (1). Saws (1) Stoves and ranges (3). Starch (3). Shovels, spades and scoops (2). Suspenders (2). School, theatre and church furniture (2). Spirituous liquors (2). Steam boilers (11). Sugar machinery (8). Steam shovels (4). Soap (6). Steam turbines (2). Steam engines (14). Steel plate work, other than steam boilers (9). Steam mains (1). Sugar cane machinery (1). Soda fountains (1). Spark plugs (1). Scott tissue towels (1). Sewing thread (1). Stampings (1). Shoe lasts (1). Shirt and collars (2). Steel blocks (1). Shoe pegs (1). Scales (1). Steel rolling doors (1). Steel lockers, racks and tables (1). Slate (1). Snap fasteners (1). Sanitary enameled ware (1). Sewing machines (3). Spring hinges (1). Sample cases (1). Screw machine products (1). Steel clothes lockers (1). Sprayers (1). Steel sash (1). Silver plated ware (1). Stationery specialties (1). Soldering fluxes (1). Steel transmission structures (1). Safety water columns (1). Store fixtures (1). Seamless tube mill machinery (1). Speedometers (1). Saddlery goods (1). Safes, vaults, etc. (1). Stationery (1). Structural and ornamental iron (1). Street lighting fixtures (1). Shoe manufacturers' supplies (1). Shoe dressings and polishes (3). Storage batteries (2). Sadirons (2). Scientific instruments (2). Steam radiators (2). Sawmill machinery (5). Steel ships (1). Sugar (2). Shoe laces (1). Spelter (1). Spring mattresses (1). Spark coils (1). Steel works equipment (1). Sandpaper (1). Silos (1). Steel furniture (3). Steel tubing (1). Storage battery cutters (1). Steam dredges (1).

Textiles, including cotton, woolen and silk (13). Textile machinery (9). Tobacco in various forms (7). Tobacco machinery (3). Typewriters (5). Toy guns (1). Tire filler (1). Type casting machines (2). Tannery machinery (2). Tannery extracts (2). Toilet articles (3). Tin and tern plate (4). Tin ointment boxes (1). Trunks (1). Table and shelf oilcloth (1). Tire fabrics (2). Time recording devices (1). Telephone equipment (2). Tacks, nails and rivets (1). Thermos bottles (1). Trench excavating equipment (1). Tank cars (1). Tractors (4). Typewriter ribbons (4). Telephone ringing machines (1). Timber preserving machinery (1). Toothpicks (1). Tungsten contact points (1).

Underwear (4). Upholstered furniture (1). Undertakers' supplies (1).

Valves (5). Vacuum machinery (2). Vacuum cleaners (2). Veneers (3). Vises (1). Vegetable paring machines (1). Vehicle springs (1). Vehicles for children (1). Ventilating apparatus (1).

Woodworking machinery (8). Windmills (3). Wire (5). Wagons (6). Wagon and carriage wheels (1). Wire rope (2). Wire fabrics (3). Wire products (2). Wire glass (1). Wrenches (2). Wooden

mallets (1). Well supplies (1). Writing inks (1). Well drilling machinery (2). Window fixtures (1). Wall paper (1). Water heaters (1). Wood screws (1). Wood finishes (1). Wheelbarrows (1). Waterworks material (1). Wooden boxes (1). Washing machines (1). Watchman's signals (1). Wooden ships (1). Wall board (1). Watches (4). Watchcases (1) Wood heels (3).

Zinc products (1).

Products not named (88).

PARTIAL USE OF THE METRIC SYSTEM IN PRODUCTION

The reports of partial use are, in some respects, the most instructive of all. From them, we learn that it is only in rare cases that the units of measure used in the production of a commodity have anything to do with its salability in any market, the calls for the metric system being always special and of no general application or significance.

For example, in substantially all lines of machinery, the watch and clock illustrations (page 34) are duplicated—foreign purchasers of automobiles, electrical, mining, ice making, agricultural machinery, etc., caring no more about the units to which the parts of these machines are made than the reader cares about the English or metric units used in the construction of his own watch. The only exception to this law is found in about one-third of the reports for machine tools. Here, the metric features called for are those few immediately concerned in measuring the products made on the machine, and no others.

Again, in the case of chemicals, it must be clear to the dullest mind that the units used in the production of the goods have nothing to do with the salability of the products. In steel and iron products—structural material, pipe, etc.—the overwhelming preponderance of English-speaking countries in the production of these goods has made their products the standard of the world as is true, also, of automobile tires, while in textiles, the letter of the American Printing Company (page 38) saying that "practically all of our goods for export trade are measured in yards" contains a volume of information regarding the use of the yard as a price unit in the metric countries.

The most striking illustration of all is found in weighing and measuring instruments which are crucial if anything can be. With them, the construction remains strictly English, the only metric feature being the graduated dial or scale by which the indications are read, and more striking still, in the case of recording instruments, these graduations are placed on ruled sheets of paper which are not even parts of the instruments.

Representatives of the following industries reply to the first question by placing their crosses in the Slightly, Considerably or Exclusively lines as indicated by the figures in parentheses.

Automobiles and automobile trucks: Not at all (22), Slightly (20), Considerably (2).

The use of the metric system in the automobile and automobile truck industry to meet the needs of export trade is limited to speedometers, spark plugs, tires and wheel rims to suit the tires. Speedometers are graduated to read in kilometers just as, for Russia, they are graduated to read in versts. In both cases, we give the customer what he wants and one practice has as much and as little significance as the other.

It will be observed that most of the automobile companies who use the metric system at all place their crosses against "Slightly" for the use of the metric system for these items. How little this means is shown by the following extracts from letters.

The Cadillac Motor Car Company say:

"Until a year ago millimeter sized wheels and tires were shipped with cars to Australia, but our distributor there changed to inch sizes. Most South American countries take inch sizes, with the exception of Chile which takes millimeter."

The Dart Motor Truck Company say:

"All the tires we have shipped on foreign shipments have been of American make and American sizes."

Dodge Brothers say:

"We furnish the standard American tires on all our cars."

The Elwell-Parker Electric Co. say:

"We have shipped trucks to Australia, New Zealand, France, Italy, England, Cuba, Ecuador and Canada with standard English sized tires."

The Ford Motor Company say:

"Our cars for export trade are always equipped with American size tires—not metric size."

The International Motor Company say:

"In all cases we have supplied tires in American dimensions such as are standard and in stock in this country."

The Lexington Motor Company say:

"We use a few metric sized rims and tires, but in our business, it only serves to cause confusion."

The Maxwell Motor Sales Corporation say:

"All of our cars which are exported are equipped with American sized tires."

The Paige-Detroit Motor Car Company say:

"At the present time, the demand for metric wheels, rims and tires is extremely limited. Since the first of the year, we have only shipped 6 cars so equipped."

Plainly, the word "Slightly" for the use of the metric system in export trade in automobiles is well chosen.

Metric spark plugs are so called by courtesy only, their only metric feature being the screw thread by which they are secured in place, all their other dimensions being English. This is an example of the practice

of the metricites who universally call anything metric if it has a single metric feature or dimension. Nor are such plugs universal in metric countries. The Cole Motor Car Company say in reference to export trade:

"We use the 7/8-18 S.A.E. standard spark plug."

The J. B. Crockett Company say:

"The percentage of metric spark plugs against those of standard thread as used by ourselves which are exported is about two-thirds metric—the balance, one-third, 1/2" and 7/8", that is, omitting the regular Champion X Ford plugs. The greater portion of Ford spark plugs shipped into foreign countries are the same as the regular standard American used here."

The Paige-Detroit Motor Car Company say:

"Occasionally, we get a request that the spark plug be metric with which request we comply. This is practically obsolete at the present time, owing to the predominance of American spark plugs, and we have not made shipment of a single car so equipped for over 18 months."

Dodge Brothers say:

"We are shipping about $1,000,000.00 annually to countries which use the metric system. All of these cars go with our standard English thread spark plugs.

Addressographs: Slightly (1). The Addressograph Company (addressing machines, in export trade 12 years) write:

"Only one request for goods to be marked in the metric system in the past 12 years."

Automobile crank shafts: Slightly (1). The Automobile Crank Shaft Corporation (in export trade three years) who make this report, say:

"About 60 per cent. of crank shafts we are making for export are in English measurements, 20 per cent. in English and metric [that is some dimensions English and some metric] and 20 per cent. in metric only."

Athletic goods: Not at all (1), Slightly (1). A. G. Spalding and Brothers (in export trade 20 years) who make this last report, say:

"We have one or two pieces of apparatus used in physical measurement which we are requested, although very seldom, to make specially to the metric system."

Agricultural machinery: Not at all (9), Considerably (1), Slightly (1). The Avery Company (in export trade 20 years) who make this last report, say that the use of the metric system relates to "Spark plugs and small equipment."

Abrasives and sharpening stones: Not at all (3), Slightly (1). The Pike Manufacturing Company (in export trade nearly 50 years) who make this last report, add the word "very" after slightly, and say:

"It would be rather hard for us to estimate the percentage of orders rendered to us in the metric system, but are safe in saying it would be a fraction of 1 per cent."

Ammunition: Not at all (1), Extensively (2).

Belting: Not at all (2), Slightly (4), Considerably (1), Extensively (1). The Detroit Oak Belting Company (in export trade three years) who report "Considerably," say:

"Some customers specify lengths in meters and widths in inches."

The Missouri Belting Company (in export trade 22 years) say:

"We make leather belting in metric dimensions on special orders only."

The Rossendale-Reddaway Belting and Hose Company who report "Extensively," say:

"We do not use it at all as far as the actual manufacturing is concerned. We do, however, receive many inquiries and orders from other countries in which they request length, breadth and thickness of belting according to the metric system, and in filling the orders, we supply them with the nearest measurements we have in feet and inches."

Brass and copper goods: Not at all (6), Slightly (2), Extensively (1). The Bridgeport Brass Company (in export trade 25 years), who report "Slightly," say:

"We have furnished during the last two or three years large quantities of brass disks for the manufacture of cartridge cases, the dimensions of which were specified in metric units. These metric units we simply translated into the corresponding English equivalents and proceeded with the order. We have made seamless tubes in a similar manner and several million copper bands for shrapnel."

C. G. Hussey & Co. (in export trade 60 years) who also report "Slightly", say:

"Goods are shipped to metric countries in both millimeter and English sizes. We should say, roughly, that the English sizes amount to about 75 per cent."

Bolts, nuts and rivets: Not at all (4), Slightly (3). Boiler tubes: Not at all (1), Considerably (1). Ball bearings: Not at all (1), Slightly (1). Balls: Not at all (2), Considerably (1). The Hoover Steel Ball Company (in export trade 3 years) who make this last report, say:

"We do not have a very large call for the metric sizes and presume this would not amount to more than 5 per cent. of our entire export orders."

Brick: Slightly (1). Boiler tube cleaners: Considerably (1). The William B. Pierce Company (in export trade 19 years) who make this last report, say:

"In countries using the metric system we merely use that system for turning and measuring the outside diameter of the machine."

Boat oars, hardwood dimension stock, etc.: Slightly (1). The Anchor Sawmills Company (in export trade 60 years) who make this report, say:

"It is very rarely that boat oars are ordered by the metric system as the English foot is used as the unit of length all over the world."

Cutting tools: Not at all (14), Slightly (4), Considerably (5). The Cleveland Twist Drill Company (in export trade 30 years) who report "Considerably," say that to France, Sweden, Italy and Spain their shipments are 90 per cent. to 100 per cent. metric. Shipments to Norway, Holland, Denmark and Russia are about 50 per cent. English and 50 per cent. metric. Shipments to Japan are about 90 per cent. English and 10 per cent. metric. Shipments to Central and South America are 95 per cent. to 100 per cent. English. The Detroit Twist Drill Company (in export trade eight years) say:

"All of our South American customers use more English sizes than metric. Some of the French, Italian, Swedish, Norwegian, Russian, in fact, most all of our customers of Continental Europe use some proportion of English sizes."

The National Tool Co. (in export trade 3 years) who report "Considerably", say:

"In most every case we have used both the millimeter and English sizes and approximately the percentage would be 50."

The Modern Tool Company (in export trade 14 years) who report "Slightly", say:

"According to our records about 10 per cent. of the tools supplied to metric countries are required in millimeter dimensions."

The Murchey Machine and Tool Company (in export trade 3 years) who report "Slightly", say:

"About one-tenth of our export business is in millimeter sizes."

There are two types of cutting tools—those which by their own size determine the size of the work done by them (twist drills, reamers, taps, dies, milling cutters for gear teeth, etc.) and those which do not (most mechanics' hand tools). The replies showing the use of the metric system relate to the former type in all cases.

The remarks under weighing and measuring instruments below apply here almost without change. Sizing tools of millimeter dimensions are not made for use at home, but to sell for use abroad.

In 1916 a report on The Metric System in Export Trade was issued from the Bureau of Standards in order to impress the people of South America with the progress of the metric system in this country.

Of thirty-three pages of illustrations of American metric products, twenty-seven show weighing and measuring instruments and sizing cutting tools made for sale and use abroad, while three of the remaining six illustrations show lathes so arranged that others may cut metric screws when necessary, but *every one of them fitted for cutting English screws as a primary function* with make-shift translating gears to make possible the cutting of metric screws should the purchaser by some chance have occasion to cut them.

To those who do not understand, the illustrations make an impressive

showing of the "progress of the metric system;" to those who do understand, they make an equally impressive showing of the lack of sense in these matters at our metric hothouse, the Bureau of Standards.

Many of these tools and instruments are of American invention. Metric countries learn of their merit and call for them. We adapt them to the needs of such customers by suitably spacing and numbering the divisions by which their indications are read, and the Bureau of Standards publishes the fact to the world as an evidence that we are "adopting" the metric system. Among the exhibits of the Bureau of Standards are metrically divided tape measures which we make for sale to metric countries and these are paraded as evidence that we are adopting the metric system!

Chemicals: Not at all (19), Slightly (1), Extensively (1). Chemical machinery: Extensively (1). The Werner and Pfleiderer Company, who report extensively say:

"When originally starting here in this country, we took over a number of patterns and drawings in metric which we have used ever since."

Corsets: Not at all (1), Slightly (2), Considerably (1). Car wheels, chilled rolls, and rolled grinding machines: Not at all (2), Slightly (1). The Lobdell Car Wheel Company (in export trade nearly 50 years) who make this last report, say:

"We occasionally get orders for chilled rolls for calendering paper to go abroad and the dimensions of the journals and necks are sometimes specified in millimeters. We have also had orders for a few wheels and axles with the metric sizes specified for the axle and hub dimensions."

Cotton duck: Not at all (2), Slightly (1). The Elm City Cotton Mills (in export trade 10 years) who make this last report, say:

"We have shipped quite a bit of cotton duck to Cuba and there have been a few instances where they have asked for metric measurements. For the last few years probably 95 per cent. of the shipments we have made have been billed and branded with the usual English measurements."

Clay working machinery: Not at all (1), Slightly (1). The American Clay Machinery Company (in export trade 37 years), who make this last report, say that this use of the system refers only to dies and moulds used in presses and other machines for making clay goods. Candles, stearine, glycerine, etc.: Not at all (1), Slightly (1).

Drop forgings: Not at all (1), Slightly (2). The Armstrong Brothers Tool Company (in export trade 25 years) who report "Slightly," say:

"Slightly here means only on size of wrench openings for some wrenches going to the Continent of Europe."

The Billings and Spencer Company (in export trade 55 years) who also report "Slightly," say also that this use of the system refers only to "openings in machine wrenches."

Electrical machinery: Not at all (14), Slightly (1). The Westing-

house Electric and Manufacturing Company (in export trade 20 years) who make this last report, say:

"Only on orders from foreign countries when they require us to follow their exact dimensions. This is required in only a very small fraction of the business taken—too small, in fact, to state in figures."

Elevators, escalators, conveying and hoisting machinery: Not at all (8), Slightly (1). Explosives: Not at all (1), Slightly (1). Electrical wires, cables and accessories: Extensively (1).

Firearms, sporting: Not at all (4), Considerably (1). The A. H. Fox Gun Company (in export trade five years) who make this last report, say:

"About half of our foreign orders are received with the dimensions of the guns in the metric system."

Firearms, military: Not at all (2), Slightly (1). Fire-clay products: Slightly (1). The Laclede-Christy Clay Products Company (in export trade "several" years), say:

"On one of the inquiries we received, the size of the material required was shown in kilos and our quotation was made on the same basis. The order, however, has not been received."

Filters: Not at all (2), Slightly (1).

Glass, including plate, window, jars and bottles: Not at all (8), Slightly (2). The Pittsburgh Plate Glass Company (in export trade three years) who make one of these reports, say:

"We have only one customer (located in Mexico) who insists upon the metric system."

Ground steel shafting: Slightly (1). The Cumberland Steel Company (in export trade 20 years) who make this report, say:

"We do not think we have finished any metric sizes for two or three years, and the quantity we made at any time is very small—hardly worth considering."

Grinding wheels: Not at all (4), Slightly (1), Extensively (1). The Abrasive Company (in export trade 17 years) who report "Slightly," say:

"The grinding wheels that we supply to countries using metric measure are according to English and metric measures. It would be difficult to give an approximate idea of the percentage of the two kinds of measurements used, but perhaps we would not be far wrong in specifying 3 per cent. metric and 97 per cent. English."

The Hampden Corundum Wheel Company (in export trade 32 years) say:

"Customers frequently order in metric specifications, but we supply the nearest English equivalents to their entire satisfaction."

Gas, gasoline, and oil engines: Not at all (12), Slightly (1). Gas engine specialties: Slightly (1). The Kokomo Electric Company (in export trade seven years) who make this last report, say:

"Only in one article—a metric thread spark plug."

Hoisting machinery: Not at all (2), Slightly (1). The Lidgerwood Manufacturing Company (in export trade 30 years) who make this last report, add "One instance only." Hammers: Slightly (1). Fayette R. Plumb, Inc. (in export trade 30 years), says:

"The only cases are a certain pattern of carpenters' hammer and a certain pattern of sledge hammer used in South America."

Handles for hand tools: Not at all (2), Slightly (1).

The Turner, Day & Woolworth Handle Co. (in export trade 30 years), who make this last report, say:

"Under normal conditions, shipments to those countries in which millimeter measurements are used will run about 25 per cent. against 75 per cent. on which inches are used."

Ice machinery: Not at all (4), Slightly (1). The Vilter Manufacturing Company (in export trade 30 years), who make this last report, say:

"We do not think we ever made any of our compressors to millimeter sizes, but have made pipes, fittings, etc., at times. [The ice machine is, essentially, a gas compressor.]"

Insulated electric wire and cables: Slightly (1).

Ingot metals: Slightly (1).

Knit goods: Not at all (2), Slightly (1). The Avalon Knitwear Company, who make this last report, say:

"We only use the metric system in our dye house, and only to a very limited extent."

Locomotives: Not at all (1), Slightly (2), Considerably (1). The Davenport Locomotive Works (in export trade 10 years) who report "Slightly," say:

"Only for track gauge of locomotives."

Leather goods: Not at all (1), Slightly (1). Lubricators: Not at all (4), Slightly (1). The Richards and Phoenix Company (in export trade six years), who make this last report, say:

"Whitworth pipe threads are usually called for."

Machine tools: Not at all (60), Slightly (32), Considerably (3).

Machine tools are the machines with which machine shops are equipped. On them all other machines of whatever kind and for whatever purpose are made and the dimensions of their parts determined. Here, if anywhere, the need of the adoption of the metric system in export trade would be imperative and the returns from this industry are hence the most instructive of all.

The returns show, as might have been expected, the greatest use of the system to be in this industry and it is precisely in this industry that this Institute had its origin and has today among its members the greatest number of representatives, which is to say that those who have had the most experience with the system are also those who have organized to resist its further extension.

Some types of machine tool are fitted with attachments for indicating sizes and adjustments, and some are not. Such attachments, like weighing and measuring instruments for metric countries, are naturally made to read in millimeters and frequently the graduations of these attachments are the only metric features of the machines. Thus we have drilling machines with indicators for the depth of the hole drilled reading in millimeters, but with no change in the machines. Since the circumferential speed of the cutting tools is an important thing to know, we also have cases in which tables are attached to the machines showing the speeds of different sized drills at different rates of revolutions per minute in meters per second instead of feet per minute. We also have milling machines in which adjustments are made through the use of screws and graduated dials. In order that the indications may be made in millimeters, the screws (three in number) are cut to metric pitches and the dials graduated to read in millimeters with no other change in the machine.

Of a special class are lathes because of their important function in cutting screws and this function has been a storm center of this controversy from the beginning. For this purpose lathes are fitted with lead, guide or master screws from which screws of other pitches are cut by the aid of combination or change gears.

How little the notation Slightly means in the machine tool industry and how few metric countries call for any metric features of machine tools are shown by the following remarks by machine tool builders. The non-technical reader may need to be reminded that the construction of a machine tool involves hundred of measurements—many of them of the highest degree of precision known to manufacturing industry, and that of these the few specified below represent all the "adoption" of the metric system asked for by buyers in metric countries. Except for lead and adjusting screws which a few metric countries call for on some machines, the requirements are too insignificant to be worth counting. Note that *about two-thirds of the replies show no metric features whatever to be asked for.*

The Automatic Machine Company (automatic threading lathes; in export trade 12 years) say:

"We furnish the various countries of Europe with our standard lead screw with the exception of France, Spain and Italy to which three countries we furnish the lathes with metric lead screws."

Baker Brothers (keyway cutting machines; in export trade 20 years) say:

"We furnish some cutting tools in metric widths for keyseats, but the majority are furnished in English measurements even for metric countries."

The E. W. Bliss Company (metal working machinery; in export trade 40 years) say:

"We do not often find it necessary to make any part of our machines to metric measurements. Occasionally, some part, where tools already existing must fit, is required to be made to dimensions in millimeters."

The Cincinnati-Bickford Tool Company (drilling machines; in export trade "many" years) say:

"We use metric speed and feed plates and give metric graduations on spindle sleeves or dial depth gages."

The Cincinnati Gear Cutting Machinery Co. (gear cutting machines; in export trade 9 years) say:

"For European countries we furnish a metric elevating screw for the work arbor and cutter arbor of metric diameter. All other dimensions are English."

The Cincinnati Milling Machine Company (milling machines; in export trade 20 years) say:

"This applies to the feed screws which, for metric countries, are made so that the dial reads in millimetres instead of thousandths of an inch. Some metric countries require cutter arbors made to metric diameters. Other countries, notably France, require cutter arbors made to the inch standard."

The Cincinnati Planer Co. (planers and boring mills; in export trade 19 years) say:

"Never called on for any changes except some graduated dials and screws to be made metric."

The Detrick and Harvey Machine Company (planers, horizontal boring machines, gun lathes, etc.; in export trade 25 years) say:

"Only in the matter of furnishing metric reading scales on certain machines. We have sold machinery in England, France, Germany, Russia, Italy, Holland, Norway, Japan, South Africa, Chile, and other foreign countries."

The Gleason Works (gear cutting machinery) say:

"The only use we make of metric dimensions in our work is when we manufacture adjusting screws to metric standards to be used in conjunction with metric scales which show relative movements of parts of the machines."

The Kempsmith Manufacturing Company (milling machines; in export trade 20 years) say:

"All machines for export to France are furnished with metric screws and dials. Otherwise our machines are built to English measurements."

The Landis Tool Company (cylindrical grinding machines; in export trade 20 years) say:

"Not over 5 per cent. of our foreign customers require metric measures."

The Lees Bradner Company (in export trade 4 years) say:

"We supply metric lead screws to France only.

The Lodge & Shipley Machine Tool Company (engine lathes; in export trade 25 years) say:

"The only metric dimensions used on the parts of any of our products are the lead screws which are made in the metric system on lathes shipped into France only."

The Lucas Machine Tool Company (horizontal boring machines; in export trade 14 years) say:

"To the extent of furnishing, in those cases specified, metric traversing screws and dials graduated in millimeters and speed and feed plates reading in millimeters instead of inches."

The Morris Machine Tool Company (lathes and radial drills; in export trade 10 years) say:

"Occasionally, we furnish lathes to cut metric pitch threads."

The Norton Grinding Company (cylindrical grinding machines; in export trade 16 years) say:

"There are four small parts of our grinding machines that we make to metric measurements for a few customers in some European countries."

The Rockford Drilling Machine Company (drilling machines; in export trade 17 years) say:

"Metric dimensions are stamped on drilling machine quill on machines for certain foreign countries."

The Springfield Machine Tool Company (lathes and shapers; in export trade 25 years) say:

"Metric system used only for French trade in which only the lead screw and change gears are metric."

The Warner & Swasey Company (turret lathes) say:

"We have furnished on special orders screw-threading dies and chuck jaws to metric sizes."

Shortly after the beginning of the great war the American Machinist sent a commissioner (Mr. O. P. Hood) to South America. Mr. Hood,who speaks both Spanish and Portugese,made the circuit of the continent spending 18 months at the task and he returned with substantially a census of the personnel and equipment of South American machine shops, which in this crucial industry, is a complete refutation of metric claims for export trade. Mr. Hood's papers show that in the machine shops of South America—of which there are more than most people realize—39.3 per cent. of the machine tools are American, 43.2 per cent. are British and the remaining 17.5 per cent. are German, Belgian and French. We are always told that South America is metric; South American shops have the world from which to buy, and they choose machine tools made to English over those made to metric measures in the ratio of nearly 5 to 1. Moreover, commerical Germany has long been splendidly represented in South America, while we have never been and Germany has had ample shipping and banking facilities which we have not.

Mechanical presses: Not at all (2), Slightly (1). The Ferracute Machine Company (in export trade 35 years) who make this last report, say:

"There are a few cases through our French agents where it is necessary that holes be tapped and bolts be threaded by the metric system, but in each case they allow us to furnish the bolt in blank and the hole drilled so that it can be properly tapped by the metric system and the bolt threaded metric system after it arrives."

Magnetos: Not at all (1), Slightly (1). Machinery and equipment pertaining to the meat industry: Slightly (1).

Optical goods: Not at all (5), Slightly (2), Considerably (2), Extensively (1).

The use of the metric system in optical work applies only to the grinding of lenses, the mechanical parts of cameras, microscopes, etc., being made to the English system. The Eastman Kodak Company say:

"Used only in connection with optical work, *i.e.*, lens manufacture."

The Spencer Lens Company (in export trade 10 years) say:

"We do use it mostly for the lens work, but are inconsistent enough to use the English system for mechanical work."

The system was not adopted for the benefit of export trade as is shown by the following from the Eastman Kodak Company:

"It is customary in this work to use the metric system of measurement, probably because the practice in U.S.A. followed foreign practice where lens optics were first perfected."

Lens manufacture is one of many examples of the manner in which an industry, when transferred from one country to another, carries with it the units of measurement on which it was developed.

Another illustration is found in shoe machinery. The United Shoe Machinery Company write:

"Our company established factories in England, France, Germany and Austria, and have exported goods and maintained subsidiary companies or branch offices in practically all of the countries of South America.

"In order to maintain uniformity, such machines as we manufacture both at home and abroad, the English system of measurements is used in all countries so that if necessary machines and parts may be supplied from one country to another."

Another illustration is found in machinery and appliances for the chemical trade, regarding which the Warner and Pfleiberer Company write:

"When originally starting here in this country, we took over a number of patterns and drawings in metric which we have used ever since."

Again, the Whithead torpedo carried the English inch from England to Austria; as, again, steel balls carried it from the United States to Germany. The methods of wholesale precision manufacture of balls were developed in this country and taken to Germany where the customary practice today is to make steel balls to inch dimensions—German formulas for the carrying capacity of ball bearings containing a factor for the diameter of the balls in English inches.

In the manufacture of silk fabrics, among Western nations, France

early gained the leading position and, as a result, the French system of numbering silk based on the denier (a weight) and the aune (a unit of length) became not only the silk standard of France, but of all countries, and is today the world standard for silk. In like manner, the early dominance of England in the cotton trade has made the English system of numbering cotton yarn based on the yard and pound the standard of the world, the only exception being France where it was found impossible to force the metric system based on the kilometer and kilogram on the cotton trade, the result being a compromise by the adoption of a system based on the kilometer and metric pound, the numbers of which were, approximately, but one-sixth less than those to which the trade had been accustomed.

Equally striking, is the establishment as world standards of the English standards for numbering linen and jute yarn.

But the most impressive example of the spread of standards of measurement as a result of industrial development is presented by Russia, whose system of linear measurements is based on the English inch and foot as a result of the visit of Peter the Great to England about 1701. Working in the English shipyards, the Russian Czar was impressed by the skill of English mechanics and when he returned home took with him a number of English workmen to introduce their trades in Russia. In doing this, they also introduced the English inch and foot which are now in general use throughout that great area known as Russia. The Russian duim is the English inch; the Russian foot is the English foot; the arshine is 28 inches; the sagene is 7, and the verst is 3500 English feet. All these are standards that will survive revolutions and invasions and are, with the language, the most stable of the country's institutions.

Oil mill machinery: Slightly (1). The American Machine and Manufacturing Company (in export trade 6 years), who make this report, say:

'We have to give feet, inches, etc. as well as metric measurements in some cases."

Oilless bearings: Slightly (1). The Bound Brook Oilless Bearing Company, who make this report, say:

"Only on rare occasions do we receive an order in metric measurements."

Oxygen apparatus: Extensively (1).

Packing house products Not at all (1), Slightly (1). Libby, Mc Neill & Libby (in export trade 40 years) write:

"About the only business which we have ever done which required special metric packing was occasional French Government business."

Power transmission machinery: Not at all (8), Slightly (3). The Dodge Manufacturing Company (in export trade for 25 years) who make one of these reports, say:

"Probably 99 per cent. of our export production is made on English measurements and weights that is, inches, feet and pounds."

The Standard Pressed Steel Company (in export trade 10 to 12 years) who make another of these reports, say:

"Our Pioneer steel shaft hangers are sold rather extensively to concerns throughout Europe and other markets where the metric system is used, and inasmuch as in some of these countries, shafting of millimeter diameter is used, it is necessary that we babbitt the bearings in our shaft hangers to a corresponding diameter."

The T. B. Woods Sons Company who make the third of these reports, say:

"The only places we use metric sizes in our work is in boring pulleys and other appliances which are used on line shafts."

Perforated metals: Slightly (3). The Harrington and King Perforating Company (in export trade "many" years), say:

"On receipt of an order it (the metric system) is changed to the English system and thus put through the factory with a few exceptions. We often use the metric system for specifying the size of perforations in our own factory and to both foreign and domestic customers."

Pipe: Not at all (8), Extensively (1). In this case, cast iron pipe. Platinum: Extensively (1). Paper: Not at all (13), Considerably (1), Extensively (1).

Picture frames and mouldings: Not at all (2), Slightly (1).

The Indiana Moulding & Frame Company, who make the last report, say:

"Very few orders received requiring lengths or sizes in meters."

Piping: Not at all (1), Slightly (1). The Ballwood Company (in export trade five years) who make this last report, say:

"We sometimes get orders for pipe, the lengths and flanges of which have to be finished to metric dimensions."

Paper cutters: Slightly (1) The Chandler & Price Company (in export trade 20 years) who make this report, say:

"On a few paper cutters, we use the metric system in graduating the brass rule on the bed."

Rubber goods, including automobile tires, hose, etc. Not at all (11), Slightly (9), Considerably (2), Extensively (1). The practice regarding automobile tires is given above under automobiles. The Boston Woven Hose and Rubber Company (in export trade 30 years) who report "Slightly" say:

"The manufacture of hose for countries using the metric system is identical with the process used for hose consumed in this country with the single exception that the hose is made of a definite number of meters long instead of feet."

The Electric Hose and Rubber Company (in export trade 12 years) who report "Slightly", say:

"We ship goods to metric countries made to both English and millimeter sizes, about 2 per cent. of which are made to millimeters and the balance to English sizes."

The Manhattan Rubber Manufacturing Company (in export trade 20 years) who report "Slightly", say:

"Some buyers in metric countries insist on metric measurements, others do not. In not more than twenty cases in a year's time goods are ordered from us with the dimensions specified in the metric system."

The Lee Tire and Rubber Company (in export trade 6 years) who report "Slightly", say:

"We ship both English and millimeter sizes to South America."

The Goodyear Tire and Rubber Company who have been widely heralded as having "adopted" the metric system, say:

"We are shipping tires made in both English and metric sizes to countries using the metric system. We estimate that somewhat less than 20 per cent. of our total tire exports are made up of metric sizes. In addition, we are actually making partial use of the metric system in manufacturing practice." [and "partial use" is as far as they will ever get.]

Railway material: Not at all (2), Slightly (2). The National Malleable Castings Company (in export trade "several" years) say:

"We have had to work from the metric system dimensions on some of the foreign blue prints that we have furnished. The use we make of the metric system is so small as hardly to be considered."

Seamless Steel Tubing: Not at all (1), Slightly (2). The Elwood Ivins Tube Works (in export trade 20 years or more) who make one of these reports say:

"When any person orders tubing made by metric measure, we immediately translate it in decimals of an inch. We never bill our tubes in metric measure, billing them in decimals of an inch. It is not by any means frequent that we get orders by metric measure."

Steel and iron products: Not at all (31), Slightly (1), Considerably (2). Shackle bolts and auto accessories: Slightly (1). The Bowen Manufacturing Company (in export trade 22 years) who make this report say:

"On one occasion we had to make a lot of spring shackle bolts having a metric thread at one end."

Sugar machinery: Not at all (8), Slightly (2). The Joubert & Goslin Machine and Foundry Company (in export trade 12 years) who make one of these reports, say:

"The only time that we are called upon to follow metric dimensions is where we furnish some repair part or make some addition to a machine built in Europe."

Lewis Colwell (in export trade 20 years) who makes the other of these reports says:

"Only when repairs or changes are required of installation of some foreign manufacture."

Scientific instruments: Not at all (2), Slightly (1), Extensively (1). The Brown Instrument Company say:

"We build instruments [pyrometers] using both the Fahrenheit and the Centigrade scales. In this country probably one out of every hundred orders calls for the Centigrade range."

Semi-rare ores and their products: Slightly (1). The Foote Mineral Company (in export trade 41 years) say:

"We believe that less than half our foreign trade requests the marks on either invoice or packages to be in metric units, and we believe that not more than 5 per cent. of it requires that the containers or goods be actually metric in character as well as in marks."

Sugar, coffee and rice machinery: Considerably (1). The Bahmann Iron Works Company (in export trade eight years) who make this report, say:

"We have considerable repair work for existing machinery in South American countries."

Steam and plumbing supplies: Not at all (4), Slightly (1). The John Simmons Company (in export trade 27 years) say:

"Lengths of pipe in meters for some countries."

Springs: Slightly (1). The Mather Spring Company who make this report say:

"We find that in general the English dimensions have proven satisfactory except in a very few cases."

Safety fuse: Slightly (1). The Ensign Bickford Company (in export trade 50 years) who make this report, say:

"For export to South America and certain other countries, we are often required to measure the length of the fuse as well as give dimensions and weights in metric units."

Shirts and collars: Not at all (2), Slightly (1). Surgical, dental and hospital equipment and supplies: Not at all (7), Slightly (1). Spark plugs: Not at all (1), Considerably (1). The New York & Brooklyn Auto Supply Company say:

"According to our experience 50 per cent. are shipped in metric thread and the balance in American threads."

Textile machinery: Not at all (9), Slightly (1). J. E. Windle (in export trade "several" years) says:

"We have had to make measuring dials register in metric measure on several machines we have exported the past few years."

Tractors: Not at all (4), Slightly (1). The Knox Motors Company (in export trade three years) say:

"Metric sized spark plugs are used in our cylinders on export shipments, also metric measure is used in some ball bearings."

Transmissions for marine explosive engines: Slightly (1). The Evans Stamping and Plating Company (in export trade six years) who make this report, say:

"On shipments to Belgium to fit shafts to metric dimensions."

Tobacco: Not at all (7), Slightly (1). Textiles: Not at all (13), Considerably (1).

Stay bolts: Slightly (1).

The Flannery Bolt Company (in export trade 10 years) who make this report, say:

"We furnished goods to certain countries where it was necessary to state both millimeter and English sizes. We have not really furnished anything to millimeter size alone."

Tool holders: Slightly (1). The Western Tool and Manufacturing Company (in export trade 10 years) say that this refers to threading tools only.

Vulcanized fibre, Extensively (1).

Watches and watch cases: Not at all (5), Extensively (2).

The metric system was not originally applied to American watch manufacture for the benefit of export trade, but because it was believed to be better adapted to the industry. The pioneer American (the Waltham) works adopted it at an early date and have continued it. Later, the Waterbury (now the Ingersoll) Works were fitted out by men from the Waltham Works who took the metric system with them, but that is as far as the influence of the Waltham Works has gone—all other American watch works conducting their operations on the English system.

Weighing and measuring instruments including pressure gauges, etc.: Slightly (8), Considerably (2). The H. W. Johns-Manville Company who report "Slightly" say:

"When we have orders for speedometers for Latin countries or Germany, we make them to show kilometers and not miles. On orders from Russia, we make them to show Russian versts and not miles. The number of instruments sold to these countries is very, very small as compared with countries using miles."

The L. S. Starrett Company (in export trade 25 years) who report "Considerably," say:

"We estimate that not more than 5 per cent. of our product is in the metric system."

The Goodell-Pratt Company (in export trade 22 years) say:

"We make a few measuring instruments with metric graduations. Other than that, we use no metric measurements at all and for an average, over a period of 20 years, 40 per cent. of our product has been exported."

The Richardson Scale Company (in export trade 12 years) who report "Slightly", say:

"Our scales being of the even arm type, our weights are all dead weights and it makes no difference what kind of weights are used." [Which is to say that the scales supplied to metric countries are *identical* with those supplied for home trade.]

American makers of weighing and measuring instruments have developed a large export trade and, for metric countries, they are, of course, made to give their *indications* in metric units. For example, weighing scales of the dial type are made to read in kilograms, linear measuring instruments in millimeters and pressure gauges in kilograms per square centimeter.

The substitution of a graduated dial reading in kilograms for one reading in pounds does not affect the construction of the scale, the dial being the only thing changed. We make and export adding machines for British currency, speedometers to read in Russian versts, weighing scales to read in Russian poods and cloth folding machines to fold fabrics to the Spanish vara. No one imagines that we thus "adopt" the pound Sterling, the verst, the pood and the vara for the benefit of export trade, and no more do we adopt the metric system when we send abroad weighing scales reading in kilograms or micrometers reading in millimeters, and for the same reason the adoption of the metric system means the *use* of the system and all these products are made not for use at home but *to sell for use abroad.*

Worm gears and lead screws: Slightly (1). The Hindley Gear Company who make this report say:

"The quantity [made to metric measurements] is so slight in proportion to the amount of business we do, that we hardly know what percentage to claim—doubtful if it amounts to ⅛ of 1 per cent."

Products not specified Slightly (1).

EXCLUSIVE USE OF THE METRIC SYSTEM IN PRODUCTION

One representative of each of the following industries replies to the first question by placing his cross in the "Exclusively" line.

Carbon products (1), proprietary medicines (1), coin operated machines and violino virtuoso instruments (1), piston head packing rings for automobiles (1), drills, reamers and tools (1).

THE SECOND QUESTION

We have found it advisable to pack our goods for trade with metric countries in containers of metric dimensions or containing metric weights to the following extent.

The use of the metric system disclosed by the second question, while of trifling importance as compared with the use covered by the first question, is even more instructive as a means of showing the slight call for its adoption for the benefit of export trade.

If we pass over the use of the system in shipments due to the fact that several foreign governments compel its use for customs purposes, the results are suitable for derision and the conclusion is forced upon us that, were this government support withdrawn and the system left to stand or fall by its merits, this commercial use of it would practically disappear from our export trade.

With the trifling number of manufacturers who report that they have found it worth while to adopt metric containers, the moral is obvious and shows the futility of, for example, the campaign for the use of such containers now being carried on by the National Wholesale Grocers Association.

We confess to surprise at the slight showing for the use of the metric system in this manner. With three producers of food products reporting slight use of metric containers (two of them for lard only), one reporting considerable use of such containers, and one extensive use, if we include corn products which are partly food products, we point out to the National Wholesale Grocers Association both the magnitude of their future work and the paucity of their past results.

The second question was intended to cover these goods which are shipped in tin cans, pasteboard boxes and other containers of definite metric weight or capacity.

Replies immediately began to come in with crosses opposite Slightly, Considerably, Extensively and even Exclusively, but with remarks added in footnotes or accompanying letters that the practice consisted of nothing more than marking weights on shipping cases, and bills of lading in kilograms to meet the requirements of foreign customs departments and consular invoices or of customers who called attention to the requirements.

This use of the metric system is on an entirely different basis from the use of metric containers. Metric containers are used because of a commercial need but this use of the system represents a case in which the laws of other countries reach into our own.

Putting a machine in a box, weighing the box in pounds and then stenciling the equivalent weight on the box in kilograms does not make it a metric container. Should the pro metric reader think it does, how would he classify a box carrying, as many do, both English and metric

weights? Is such a box English, metric, both or neither? Plainly, neither, because made without reference to the weight of its contents which may be expressed equally well in any system of units whatever.

To clear up this point the following rubber stamp impression was added to outgoing questionnaires, alongside the second question:

If this use of the metric system consists of nothing more than giving weights of shipments in kilograms to meet Customs and Consular Invoice regulations, that fact should be noted under Remarks and Particulars.

In many cases in which, from their nature, the goods could not be shipped in containers this rubber stamp impression was ignored and Form Letter No. 3[1] was therefore sent to those making such returns for goods of such character as not to be shipped in containers. The replies received were added to the questionnaires.

Following is a summary of the replies to the second question.

	Count of returns	Per cent.
Not at all	746	51.6
Slightly	24	1.7
Considerably	16	1.1
Extensively	13	0.9
Exclusively	1	Negligible
Give metric weights and, in a few cases, dimensions on shipping cases and bills of lading	546	37.9
No reply to this question	99	6.8
Total	1445	100.00

TABLE 2.—SUMMARY OF REPLIES TO THE SECOND QUESTION

FORM LETTER NO. 3[1]

Gentlemen:

Several of those who have replied to our questionnaire added after the second question relating to the use of the metric packages or containers in foreign trade that their use signified no more than the giving of weights of shipments in kilograms in order to conform to the requirements of the Customs and Consular invoices, and no doubt there are other cases to which this explanation would apply.

This use of the metric system should, of course, be recorded, but to it a statement of the practise should properly be added. As you are one of those who reported the use of metric containers or packages, I write to ask if in your case the practice consists of anything more than giving the weights of shipments in kilograms, as explained above. Your answer will greatly facilitate the summarizing of our numerous replies, and we hope to hear from you again.

Form Letter No. 3 was not in all cases replied to and there remain several classes of goods which cannot possibly be shipped in tin cans, pasteboard boxes or other metric containers. Those which obviously belong in these classes are as follows:

Slightly: Automobile trucks (1), Elevating machines (1), Pumps (1), Automobile accessories (1), Oil mill machinery (1), Rock crushing machinery (1), Oil well supplies (1), Gas engines (1), Wrenches (1), Belting (1), Oiled clothing (1), Counting Machines (1), Cotton goods (1), Shirts and collars (1), Steel castings, wheels and springs (1). Total (15).

Considerably: Grain cleaning machines (1), Electrical machinery (1), Chains (1), Mining machinery (1), Ice making machinery (1), Automobile tires (1), Machine tools (1), Fertilizer machines (1), Bolts, nuts, and rivets (1). Total (9).

Extensively: Cast iron pipe (1), Automobile tires (1), Paper (1), Cotton duck (1), Athletic goods (1), Gas meters (1). Total (6).

Exclusively: Machinery pertaining to the meat industry (1).

There remain the following industries which are here credited with the use of metric containers.

Slightly: Food products (3) (in two cases, curiously enough, lard only), Photographic apparatus materials and supplies (1), Tape measures (1), Petroleum products (1), Tobacco products (1), Rubber goods (1), zinc products (1). Total (9).

Considerably: Food products (1), Scientific apparatus (1), Flour and feed (1), Candles, stearine and glycerine (1), Varnishes, etc. (1), Lubricants (1), Lithopone (1). Total (7).

Extensively: Corn products (1), Belt preservatives (1), Chemicals (2), Candles, stearine and oil (1), Radium, vanadium and uranium (1), Products not named (1). Total (7).

Exclusively: None.

Put in tabular form, we have the following figures for those which may be credited with the use of metric containers, although some of them are very, very doubtful:

	Count of returns	Per cent.
Slightly	9	0.6
Considerably	7	0.49
Extensively	7	0.49
Exclusively	0	0.0
Total	23	1.58

Repeatedly, in these papers such expressions as "to South America only," or "to certain South American countries" appear, with several special references to Chile as the most insistent of all countries in this

matter. A few follow the practice when shipping to some European countries, but the requirement that bills of lading and weights of parcels shall be given in metric terms appears to be confined to South American, and, perhaps, Central American countries.

Replies to the number of 106 place the cross for the second question in the Not at All line, and follow this under Remarks and Particulars with the statement that they make out shipping documents and give weights of shipping parcels in metric units. Such replies are clearly a discrimination between metric containers and the giving of weights of shipments in metric terms, and, in the intended meaning of the second question, should be included in the Not at All replies. This, however, has not been done, all such replies being included in the classification of those who give metric weights on shipping cases and bills of lading.

The questionnaire was not framed to bring out the effect of the laws of foreign countries on shipping methods and, had it been so framed, no definite summary of the facts could have been obtained because the extent of this use of metric units in the case of any shipper depends upon the countries to which he makes shipments. However, many remarks upon the papers throw light upon this phase of the subject. Of these, the following are typical examples:

"In a small part of our shipments, we find it necessary to give the weights in kilograms." (In export trade 10 years.)

"In some instances we have had to make crates with metric dimensions and weights, and have given metric dimensions on invoices." (15 years.)

"We sometimes mark tags and boxes with the metric system."

"Possibly 2 per cent. of export shipments." (10 to 15 years.)

"This is not required on more than 10 per cent. of our export shipments." (25 years.)

"In some instances we have been requested to put the weights in the metric system as well as our own." (135 years.)

"They [metric units] are used in this connection but slightly." (A great many years.)

"Only a very few times." (8 years.)

"We have only made two or three shipments during the past year where they required us to weigh the articles in kilos." (3 years.)

"The number of these requests have been few."

"In a few cases, we have been asked to mark our cases using the metric system for weights and measurements." (5 years.)

"This, however, was done only in possibly a half-dozen instances." (3 years.)

"Crates marked with weights in kilos in a few shipments." (8 years.)

"We have been called upon to pack goods according to metric weights and dimensions to a small extent." (2 years.)

"We have not found it necessary to use metric dimensions and metric weights on more than three or four occasions." (12 years.)

"In a very few instances, we are asked to give weights to the customer in kilos." (25 years.)

"In shipping, we are sometimes required to mark weights of cases in kilos." (40 years.)

"In some cases, mark export packages with metric weights."

"Occasionally, besides the English net and gross weights, we are requested also to give the kilos." (9 years.)

"Sometimes asked to give all particulars of weights and measurements in metric figures." (60 years.)

"For customs purposes in a very few instances." (12 years.)

"Occasionally we have a request to give size of crate and weight of shipment in advance in the metric system." (15 years.)

"Applies to about 1 per cent. of our shipments." (20 years.)

"Occasionally requested to give not only the weights in kilos, but also the metric measurements of the packages." (10 years.)

"This applies to dimensions of packing cases which all countries accept from us in cubic feet and cubic inches." (10 years).

"The request for use of the metric system is not general or universal from all our customers in any one country. Some customers require it, while others in the same country do not." (30 years.)

"In a few instances, weights in kilos have been required." (25 years.)

"Only on rare occasions." (20 years.)

"In a few cases we have been asked to give weights in kilograms." (25 years.)

"Weights of shipments and dimensions of packages in a very few cases were given in metric units." (30 years.)

"Occasionally, when so specified." (More than 30 years.)

"Very seldom are we required to use the metric system." (30 years.)

"Occasionally we give weights of cases in kilos." (20 years.)

"In a very few instances." (20 years.)

"We occasionally have to state weights in kilos." (30 years.)

"Weights in kilos, sometimes." (20 years.)

"Requests come very infrequently." (17 years.)

"Occasional marking in kilograms." (20 years.)

"Sometimes have to do this." (15 years.)

"Only in rare instances." (15 years.)

"Metric system used only in occasional shipments." (10 years.)

"Only on one shipment have we ever been asked to give metric measurements." (15 years.)

"Occasionally, besides the English net and gross weights, we are requested to also give the kilos." (15 years.)

"We sometimes mark the cases with weights and measurements in the metric system." (10 years.)

"In remote instances have given the weight in kilograms." (10 years.)

"In a few instances, we have had to state weights in kilos." (5 years.)

"We are occasionally requested to mark weights in kilos." (6 years.)

"We sometimes give weights in kilograms." ("several" years.)

"A few weights in kilos only."

"We are occasionally called on to convert our shipping weights to kilos on export shipments." (4 years.)

"In some cases where customers request it we stencil on outside of cases metric measurements." (25 years.)

"Ship both English and metric containers to the same countries." ("Almost a century.")

"Have several times shown metric dimensions, weights, etc., on invoices and cases." (20 years.)

"Occasionally give weights of shipments in kilograms." (30 years.)

Many more similar quotations could be given but the above are sufficient.

THE THIRD QUESTION

In our literature for, and correspondence with, metric countries, we have found it advisable to give information regarding weights, output, capacities, over all dimensions, etc., in metric terms as follows:

Following is a summary of the replies to the third question:

	Count of returns	Per cent.
Not at all	835	57.8
Slightly	279	19.3
Considerably	114	7.9
Extensively	78	5.4
Exclusively	38	2.6
No answer to this question	101	7.0
Total	1445	100.00

TABLE 3.—SUMMARY OF REPLIES TO THE THIRD QUESTION

The further we proceed with this inquiry, the more convincing do the results become. The use of the system covered by the third question involves so little that, did the claims made for it have any truth behind them, this use would be universal.

In the case of machinery, it involves no more than the giving of capacities, weights and over all dimensions in metric equivalents, in the case of structural materials, the giving of weights in kilograms per meter instead of pounds per yard with leading dimensions of sections in approximate metric equivalents, and in other cases the giving of prices per kilogram or per liter instead of per pound or per gallon.

Why do but 42 per cent. of our exporting manufacturers find occasion to make any use of the system and but 8 per cent. of them to make extensive or exclusive use of it in this simple way? Because buyers in other countries understand our units precisely as we understand theirs—but better.

Consider that 90 per cent. of the great discoveries and inventions which form the bases of modern industry have been made in our own or the mother country; consider that, but for the ancient industries, of which all countries have their share, the industries of today in metric countries are little more than copies of those which have had their origin and development in English speaking countries; consider that these are the two great manufacturing nations of the world, and that for more than a century they have been distributing the products of their factories—made always to the English units—throughout the civilized world, and it will be seen that the claim that others "do not under-

stand" the meanings and values of the English inch, foot, yard and pound can have no foundation.

CONCLUSION

The conclusion is that the commerce of the world is conducted by the English system, and that the current phrase "the international metric system" is nothing but a pretext and a sham. From Table I (page 38), we learn that 82 per cent. of our exporters to metric countries use the system *not at all* in production, while 14 per cent. use it partially and in ways that, when explained, excite derision, and a lonesome three-tenths of one per cent. really use it exclusively.

In the commercial use of the system, the results are equally striking. By the supplementary table (page 68) we find that one and six-tenths per cent. of our exporters thus use the system in reponse to a commercial need, *not one* exclusively, and, while 38 per cent. make some use of it in shipments because compelled to do so by the laws of foreign countries, these uses, in the light of the extracts from letters on pages 69 and 70 are, again, fit only for derision and show how trifling is the influence of such laws when confronted with the customs of commerce.

It is for those who know the facts to denounce the arrogance, pretensions, and, deceit, with which the metric system has been bolstered up, and to proclaim the English system as the one which, in the face of vast governmental opposition, has conquered the world.

CHAPTER IV

CONFIRMATIONS OF THESE FINDINGS

The subject matter of Chapter II was first published as a report on The Weights and Measures of Latin America by the American Society of Mechanical Engineers in 1918. During its preparation and since its publication some remarkable confirmations of its findings have come to light.

It should be remembered that prior to the appearance of that Report, Latin America, like many other countries, had always been claimed by the metric party to be "purely metric." We were told that "they had forgotten their old units," that "our units are meaningless to them" and that "we must deal with them in language they understand." Will the reader please contract these assertions with the following facts from independent and, in some cases metric, sources:

CONFIRMATIONS FROM THE DEPARTMENT OF COMMERCE AND OTHERS

Some years ago—that is before the war—our Department of Commerce sent Mr. W. Graham Clark as a special agent to Latin America to investigate the conditions and trade opportunities for the sale there of the products of our textile mills. Mr. Clark spent several years in personal investigations upon the ground. He went to Latin America in order to determine what we should do in order to gain the trade of those countries and in not one of his reports is there so much as a word regarding the adoption of the metric system. Moreover, he names the system of measurements used in nine of the countries which he visited, and in every case he confirms these findings.

Since this Report was published a book—Getting Together with Latin America—has appeared from the pen of Mr. A. Hyatt Verrill and from the press of E. P. Dutton & Co. Mr. Verrill has lived for many years in Latin American countries and, upon his return to this country, he prepared this book in order to place before our exporters the things that they should do in order to sell goods to Latin America and, like Mr. Clark, he does not even mention the adoption of the metric system. Nearly half of his book is given up to an appendix in which is given statistical and other detailed information regarding the various countries which are arranged in alphabetical order. For eighteen countries he names the

system of weights and measures used, and he confirms these findings in every case except one.

Unknown to the author until the results were placed in his hands, Mr. Henry R. Towne, President of the Yale & Towne Manufacturing Company sent a questionnaire to the branches and representatives of that company in various parts of the world and the answers to that questionnaire confirm these findings in every instance.

In 1913, Dr. F. S. Holbrook of the Bureau of Standards went to Porto Rico to assist in weights and measures legislation. His report, which was published as part of the proceedings of the annual Weights and Measures Conference held at the Bureau of Standards in 1914, absolutely confirms these findings for Porto Rico.

CONFIRMATION FROM THE BUREAU OF STANDARDS

Quite the most remarkable confirmation of these findings is found in Commerce Reports for April 21, 1919 under the subhead Prepared by the Latin American Division of the Bureau of Foreign and Domestic Commerce with Assistance from the Bureau of Standards. From this article the following are quotations:

Uruguay.—This system was adopted in 1862 . . . but it did not come into general use until made compulsory by law in 1894, providing that fines should be imposed for the use of other systems. It was found, however, that customers continued to call for articles under the old names.

Argentina.—While the metric system is legal, it is only compulsory in government departments, and a number of old Spanish measures still survive.

Bolivia.—The old Spanish units, which vary greatly, are in general use outside of government and railway circles.

Brazil.—The Almanach Commercial Brasileiro states that the metric system was adopted in 1862, and made obligatory in 1874, adding, however, that as many of the old measures are still used in the interior of the country, tables of equivalents are given in the Almanach.

Chili.—Many of the country districts still cling to the old units.

Peru.—The American Commercial Attache at Lima reported that El Comercio "speaks of the lame metric system of Peru," because many articles are purchased at wholesale by the metric system, and retailed by another system of weights and measures.

Venezuela.—In spite of the stringent laws, old people and country people cling to the old units in domestic life, and this will only be changed by the growing up of a new generation.

According to the Report to the International High Commission on The Metric System in Export Trade, prepared by the Director of the Bureau

of Standards, the metric system is "obligatory" in all of these seven countries except Bolivia and Venezuela.

When did the Director of the Bureau of Standards stop accepting and publishing floating rumor and gossip as fact and begin a real investigation of facts? Since learning that this rumor and gossip is unfounded has he withdrawn his report from circulation?

When reading these extracts from Commerce Reports, it should not be forgotten that the seven countries referred to therein are all from those in which Chapter II shows the system to have made the greatest progress, while to the ten countries wherein Chapter II shows the system to have made substantially no progress among the people and to the five countries in which the English units are shown to be used far more than the metric, no reference whatever is made.

During the years 1917 and 1918 the author attended three foreign trade conventions—those of the National Foreign Trade Council and of the American Manufacturers Export Association. At all of these Conventions, so many papers were offered that it was necessary for them to be held in parallel sessions. At one of them an afternoon session was devoted to education for foreign trade and in no one of the papers read at that session or at any other session of any of the conventions was the adoption of the metric system for the benefit of export trade so much as mentioned, and it is to be remembered that the papers read at these Conventions were prepared by those who are in immediate contact with export trade.

CONFIRMATIONS BY METRIC ADVOCATES

It is a striking fact that most of our contentions have been admitted by the better informed metric advocates, whose adherence to the propaganda is a counsel of perfection rather than an expectation of early improvement. From many such admissions[1] the following is selected from a pro-metric article by a staunch metric advocate, Prof. J. Le Conte Stevens, published in *Science* for Aug. 5, 1904.

"A century has not been sufficient to cause the abolition of old names and units among the common people in France, whether in city or country, resort to them being usual when no penalty is involved. The same is true in Germany and Switzerland and every other country where the metric system is in business transactions, either obligatory or permissive. . . . Reasonably complete assimilation will take several generations. . . . Advocates of the metric system deceive themselves if they think that new standards can be established among the masses by statute or otherwise within a few years. . . . The first result will be, not the abolition of

[1] A delightfully naive admission is that of Dr. Simon Newcomb before the House of Representatives Committee on Coinage, Weights and Measures, Feb. 8, 1902: "So far as every day purposes are concerned, I do not know of any particular advantage." Admissions from pro-metric sources regarding the time required to learn the system will be found in Chapter XI, Learning the Metric System.

confusion, but the increase of confusion. . . . None of us today will live to see anything better than good progress on the part of the general public in getting accustomed to the new standards and losing devotion to the old ones.

"Attempts in France to dispel this chaos by legislation in behalf of the metric system have been rewarded with little or no success. The statutes were passed, but had no life. Scarcely any better success has been had in Germany or, indeed, anywhere else.

"Hope of general adoption within a few years after the passage of appropriate legislation has to be very limited. . . . . Nor must we claim that such adoption will simplify our weights and measures at first; it will merely add to the diversity."

See also the quotation from Professors Hallock and Wade given in the Preface.

These findings are thus established and acknowledged. They can no more be doubted than can the multiplication table, while, against them, are nothing but assumptions endlessly repeated.

CHAPTER V

ALL METRIC ARGUMENTS DESTROYED

On its face the investigation of the weights and measures of Latin America given in Chapter II sets forth a volume of facts, but it also disproves many theories.

The first theory is that it is an easy and simple matter for a country to change its system of weights and measures. Here we have the results of twenty attempts to bring about this change, most of which date from about the middle of the last century. With but one exception the result has been grotesque failure, while in none has the attempt to retire old units been successful.

It is on this theory that the entire metric case is based. Once one has accepted the idea that a country may easily change its weights and measures, it is a short step to the conclusion that those who have tried it have succeeded, and then another short step to the conclusion that we can succeed. The question at issue is one not of belief but of fact. With twenty failures after, in most cases, more than a half century of effort, the fact is proven.

The second theory is that the adoption of the metric system does away with confusion of weights and measures. These reports show that the actual result is to introduce and not eliminate confusion.

The third theory is that the metric system is in universal use, except in the United States, the British Empire and Russia. These reports show that in no country investigated is the system universal.

The fourth theory is that we must adopt the metric system if we are to succeed in selling goods to Spanish America. These reports show that if we are to change our weights and measures in order to conform to the practice of Spanish America, we should adopt the Spanish and not the metric system.

The fifth theory is that the "adoption" of the metric system leads to an important saving of time in primary education. Clearly, with a mixture of systems in use, children have more and not less to learn.

The sixth theory is that the adoption of the metric system leads to a saving of time in calculations. Clearly, with this mixture of systems in use, involving the constant necessity for conversions between them, the labor of calculations is increased and not reduced. For example, consider the purchase at wholesale by the meter and the sale at retail by the

vara, or at wholesale by the kilogram and at retail by the libra, all of which practices are found in Chapter II.

The seventh theory is that the persistence of old units in metric countries is a persistence of names but not of things—that the practice is nothing more than the use of old names for new units. One of the most recent formal statements of this theory is by Dr. William C. Wells, Chief Statistician of the Pan-American Union, who says (*Bulletin* of the Pan-American Union, January, 1917):

> It has been found somewhat difficult in countries adopting the metric scale to do away with the names of the most-used measures such as yards, quarts, pounds, miles, etc., or rather of the equivalents of those English words in the language of the country adopting the metric system. . . . It has been found very easy to substitute the thing, although sometimes difficult to substitute the word. . . . . Scarcely a vestige of the old system is left in any country that adopted the metric system. Now and then in Latin American countries one will hear the old words, but almost always with a meaning adapted to the new scale.

These replies are sprinkled with such expressions as these:

> "Same as in the United States." "English sizes." "For distance, the English mile." "English and metric system." "French and American indiscriminately." "Thickness of lumber is always in English inches." "Metric system infrequently." "The two standards are used indiscriminately." "The meter is used very little." "The artisans of the country use in their calculations the Spanish vara as their standard." "Our standard of weight is the quintal of 100 Spanish pounds." "The people continue to use the old Spanish measures." "At retail, vara; at wholesale, yard, meter." "While the metric system is legal it is not enforced." "In domestic business, only the Spanish system is used." "A few French articles are in metric sizes." "The cuadra is still commonly used, but is prohibited in the documents." "The English measures prevail." "Generally the English foot, exceptionally the meter." "The old Brazilian system is still commonly used." "Cloths are sold indiscriminately by meters, varas and yards." "Occasionally the metric ton." "The metric measurements are sometimes used."

Such expressions as the above, of which there are many more, cannot be thus explained.

Many of these reports *give values of the Spanish in terms of metric and English units* which show that the old names are not used for the new units. Of these, a few of many examples follow (note that the libra is *not* a half kilogram):

> From Costa Rica: Vara, 0.836 meter; libra, 460 grams; cuartillo, 4.165 liters; botella, 0.67 liter; manzana, 6988 square meters.
>
> From Argentina: Vara, 0.866 meter; pie, 0.289 meter; libra, 0.4594 kilogram; tonelada, 918.8 kilograms.
>
> From Nicaragua: Vara, 33 inches; libra, 16 onzas; fanega, 288 libras; manzana, 10,000 square varas.
>
> From Ecuador: Vara, 84 centimeters; libra, 16 onzas; cuadra, 100 square varas.
>
> From Guatemala: Vara, 2.78 feet; manzana, 10,000 square varas; caballeria, 64 manzanas; cuadra, 625 square varas.

From Mexico: Vara, 2.7 feet; onza, 1.0148 ounces avoirdupois; cuartillo, 1.7 quarts; sitio, 1755 hectares; caballeria, 42 hectares.

From Venezuela: Vara, 0.836 meter; pie, 0.279 meter; pulgada, 0.023 meter; libra, 460 grams; arroba, 11.5 kilograms.

From Honduras: Vara "about 33 inches;" manzana, "100 square English yards."

From Brazil: Libra, 0.45905 kilogram; arroba, 14.6896 kilograms; oitava, 3.586 grams; quartilho, 0.665 liter; canada, 2.662 liters.

From Peru: Vara, 83 centimeters; topo, 5000 square varas, or 3485 square meters; quintal, 46 kilograms; marco, 228 grams.

From Chile: Quintal, 46 kilograms; arroba, 11½ kilograms; corcada (cord for wood), 6 pies × 3 pies × 3 pies.

More might be given to the point of weariness, but the above are sufficient. Not one of all the hundreds of sheets comprising the replies to the Latin American questionnaire contains a single item to substantiate the theory advanced by Dr. Wells. No proof of it has ever been offered; it is clearly untenable and must be dismissed.

The eighth theory is that we will use metric equivalents for English sizes, or, as the metric party put it, "Whatever is manufactured must be actually the same size or weight as before. It is merely a matter of a new term of expression." Nothing to justify this theory can be found in these papers, no single example of this practice being found therein. Articles manufactured to the inch (wearing apparel, pipe, lumber, etc.) are uniformly sold by the unit to which they were made. This theory is discussed more at length in Chapter XV.

CHAPTER VI

THE METRIC SYSTEM IN GREAT BRITAIN

A favorite topic of the metricites is the supposed immanence of the adoption of the metric system in Great Britain. The following extracts from the reports of four British Parliamentary Committees will show how much foundation exists for these claims:

FROM THE REPORT OF THE RECONSTRUCTION COMMITTEE ON COMMERCIAL AND INDUSTRIAL POLICY AFTER THE WAR

Having given very full consideration to the subject, we are unable to recommend the compulsory adoption of the metric system in this country.

As regards compulsion, the view taken by successive Ministers since 1887 has been, in the main, that there is no evidence that the change is desired by the great mass of retail shop keepers and their customers, and that their opposition would probably render it quite impracticable.

In our opinion it is absolutely certain that the anticipated uniformity could not be obtained for a very long period, if ever.

There is, further, the serious objection that, if we induced the above-mentioned countries to change over to the metric system, we should be surrendering to Germany the advantages which our manufacturers now enjoy over hers both in her markets and in our own.

In textiles, British measures are widely recognized all over the world even in metric countries, and in the cotton trade British "counts" have become the standard. By abondoning them, we should jeopardize our supremacy in this respect.

The foregoing objections hold good on the assumption that, on the whole, the metric system is superior to British weights and measures. This assumption is, however, denied by many opponents of the change, particularly by representatives of the cotton industry. It is contended that the metric system is not satisfactorily correlated, that the British units are superior, and that, for practical purposes, binary divisions are better than decimals. . . . Lancashire witnesses are emphatically of opinion that the metric system is unsuitable for cotton manufacture, and they point to the fact that, in metric countries, it has to be modified for that purpose.

In referring to these considerations, we have to point out that there is no unanimity as to the theoretical merits of the metric system as com-

pared with our own. The practical argument that its adoption is desirable in order to secure uniformity in the markets of the world has been shown to be unfounded. We are not satisfied by any evidence which has been brought before us that trade has been actually lost to this country owing to the fact that the use of the metric system is not compulsory. . . . To attempt to make the use of the system universal and obligatory in this country would cause great loss and confusion at a particularly inopportune moment for the sake of distant and doubtful advantages. We are convinced that so far from assisting in the re-establishment of British trade after the war, such a measure would seriously hamper it.

As regards the educational advantages claimed for the change, we have been referred to a statement quoted by the Select Committee of 1895 that no less than one year's school time would be saved if the metric system were taught in the place of that now in use. The information that we have received does not support that statement.

It is often popularly supposed that the introduction of the metric system would render possible the immediate sweeping away of many complicated and varying weights and measures. As we have already indicated, this belief is, in our opinion, wholly fallacious.

We are not convinced that the metric system is, upon the whole, even theoretically superior to the British system, and we are satisfied that the practical objections to the proposed change are such as decisively to outweigh any advantages which are claimed for it.

Dated, December 3, 1917

FROM THE REPORT OF THE COMMITTEE REPRESENTING THE TEXTILE TRADES

The great British textile trades—and more particularly, the cotton trade—are so predominant in the world that similar industries in other countries have had, in the main, to follow their lead and to accept their technical standards. For instance, the "counts" of cotton yarn used in most metric as well as non-metric countries are the English "counts." . . . All calculations of cost are made upon the basis of these lengths and weights and any change would produce for a long time an almost world-wide confusion. Then, the yard is so well known in India and China as to have become the linear measure of foreign trade, and a change to the meter would cause confusion and embarrassment in the largest and most conservative cotton using markets in the world. All our textile machinery in this country and in most of the countries supplied with British machinery is based upon British measures, and, as it would be too costly to alter it, it would obviously take many years to replace it, during which period spare parts would have to be provided in the old measurements, while all new machinery would be based upon metric measurements. For these reasons, amongst others, we understand that the Federation of

Master Spinners Associations and the Cotton Spinners and Manufacturers Association are opposed to any change. We consider these objections on the part of the cotton trade add great weight and we believe they are applicable in varying degrees to other textile industries. An argument of great force against our adoption of the metric system is to be found in the fact that a larger proportion of our textile export trade is done with non-metric countries than with metric countries. The yard is the standard of measurement in almost all the great markets of the East, in the United States, and throughout the British Empire. . . . If our present system is a disadvantage to us in dealing with the minority using the metric system, our metric competitors must find the metric system a still greater disadvantage to them in dealing with a majority not using the metric system. Dated, May 22, 1917.

FROM THE REPORT OF THE BRITISH COMMITTEE REPRESENTING THE SHIPPING AND SHIPBUILDING INDUSTRIES

So far as shipbuilding and marine engineering are concerned, we see no reason for the change. That part of the metric system involving the decimal subdivision of time and the right angle is most objectionable, and, if adopted, would most seriously prejudice the interests of navigation.

The difficulty in general business between this country and countries which have adopted the metric system arises principally from the fact that the meter does not correspond to any even unit of our measures. Had the meter been forty inches instead of approximately 39.28 a great deal of the present agitation would lose its force. Broadly, there seems no more reason for this country and the United States of America, the largest manufacturing nations in the world, to adopt the meter than for the metric nations to alter the meter to forty inches.

Dated, July, 1917.

FROM THE REPORT OF THE COMMITTEE REPRESENTING THE ENGINEERING TRADES

There is no demand from the side of the manufacturer for the abandonment of the inch measure and pound weight and the compulsory adoption of the metric system. . . . There are also two strong reasons among others against any change at the present time. First, that the expense of the change would be so great in replacement of measuring instruments, lathe screws, etc., that the trade could not bear it at a time when its recuperative powers will be so severely taxed.

Dated, March 21, 1917.

A letter from the secretary of the British Weights and Measures Association, dated October 10, 1919, says in part: "The agitation is dead here."

CHAPTER VII

IS THE METRIC SYSTEM BETTER THAN OTHERS?

The movement for the adoption of the metric system has as its basic assumption the belief that the system is better than the standard system. It is true that some who have tried it report that they find it better, but others who also have tried it report that they find it no better and even not so good.

THE VERDICT OF FRANCE

It is, however, both impossible and unnecessary to take a census among these people because the overwhelming judgment of the world is against the system, while the clearest of all verdicts comes from France. The metric system was originally promulgated in France by compulsory law in 1793. This law continued in force for 19 years, or until 1812 when, under Napoleon who had no faith in the system, it was repealed, and the people were permitted to resume their old measures. This they did at once, reverting to the truly universal system in which 12 inches make a foot, 3 feet make a yard, and 16 ounces make a pound.

To distinguish by name this system from the metric system, it received the official title the Système Usuelle, and, while a book might be written on this reversion of the French people to their old measures, it could add nothing to the force of this title which, in two words, tells the whole story.

This Système Usuelle continued in use for 25 years or until 1837 when metric force laws were reimposed. The new laws, however, omitted integral parts of the original system, namely, those for a year of 10 months, a week of 10 days, a day of 10 hours and a decimally divided circle and compass. The new laws, at least in their enforcement, related only to the units of length, weight and capacity which fragments of the original system, as introduced by LaPlace and his associates, are now, by convenient fiction, called the metric system.

The discarded portions are integral and essential portions of the metric system. It was to insure correlation between angular and linear measurements of the earth's surface that the arc of the meridian was measured[1] as it was to provide correlation between measurements of longitude and time that the decimal circle and clock were included.[2]

[1] The kilometer was to measure a minute of arc of a great circle of the earth's circumference by the 400 degree divisions.

[2] One decimal hour difference of time was to equal 40 degrees of longitude by the 400 degree circle.

When these units failed, as they promptly did, the meter lost all excuse for existence.

But how are we to account for the reversion of the French people to their old measures as soon as they were given the opportunity? If the metric units are better than the old ones, are not 19 years of their enforced use sufficient to demonstrate the fact? Is it not clear that the French people reverted to their old measures because they found them better adapted to their purposes than the new? This is the only possible explanation and it is to be remembered that this is not the opinion of a few individuals but the verdict of the nation.

As Herbert Spencer put it:

"For half a century after the metric system had been legally established the French did not discover its convenience. The alleged discovery of its convenience went along with the discovery that they would be punished if they did not use it."

What, however, are the results of the reimposition of the metric system in 1837? These results are summarized in an official communication by M. Gaston Doumergue, French Minister of Commerce, Industry and Labor to local French Chambers of Commerce in 1906 of which the following are extracts in translation:[1]

"My department at different times has been called upon to give to the Department of Weights and Measures instructions for accomplishing the total suppression of the measures and weights prohibited by the old law of July 4, 1837, by the seizure of the prohibited articles. The department in spite of all such efforts has not succeeded in attaining the desired result. The situation appears to be due to the persistence with which certain trades continue to use the prohibited weights and measures.

"I have learned that in certain industries the advertisements, prospectuses, catalogs, etc., used by the merchants among themselves and also for sending to their customers contain the illegal expressions. The merchants will invoke, without doubt, the necessity under which they find themselves not to change the existing order of things for fear that thereby they may lose orders for their goods. They thus continue to designate in lignes and inches all the articles they sell.

"I do not consider it worth while to enumerate here the industries and professions which have continued to employ the proscribed standards, but they are still numerous and most of them known to members of your organization."

The letter concludes with an appeal to the chambers of commerce to use their influence to bring about a renunciation of this illegal practice. Along with this should go the following from the reply of the Chamber of Commerce at Amiens:

"The Chamber considers that, in view of the customs adopted by certain traders, it seems difficult if not impossible to arrive at a complete suppression of the actual conditions; that, moreover, such a radical and immediate suppression would cause profound disturbance in many industries."

"Such a radical and immediate suppression would cause profound disturbance in many industries"—and this at the end of 112 years of effort and of 70 years of compulsory law!

[1] We have in this office an official copy of this communication in the original French.

THE VERDICT OF LATIN AMERICA

To the people of no other country has been given this opportunity to express their preference between the two systems after a trial of the new, but the verdict of Latin America, as given in detail in Chapter II, is unmistakable. The system was adopted in most of the Latin American countries more than half a century ago—in the decade between 1850 and 1860—and today the people use it only to the extent that they are compelled by law.

In but one country—Uraguay—is it really adopted for domestic purchases and sales and this because of laws, which, to us easy-going Anglo-Saxons, seem fairly grotesque, and, moreover, even those laws are but partially effective as, in spite of them, we find many exceptions.

Argentina and Venezuela also have drastic laws but they are not, apparently, so rigidly enforced, as in those countries we find a much larger use of the old measures. In all Latin American countries the use of the system is in exact accordance with the severity of the laws, and in most of them, among the people, it is used but little. In ten of them it can scarcely be found in popular usage while in five, the English units are used far more than the metric, although these five, like the others, are, in metric literature, claimed to be purely metric. Is not half a century of tutelage enough to demonstrate the advantages of the system, if they exist? Is it not clear that the people of Latin America continue to use the old units because they find them better adapted to their purposes than the new ones?

The preference of the people of Latin America for the ancient system is not confined to usage in domestic purchases and sales. We have an accurate census[1] of the machine tools in Latin American shops and factories which is a striking example of this preference.

For the benefit of the non-technical reader it should be explained that machine tools are the machines with which machine shops are equipped. They are the foundation of modern mechanical industry, being the parents of all other machines of whatever kind and purpose since all parts of such machines are made thereon and on them every dimension of every part is determined. This is true even of the implements of war as the world has recently learned, war being, in fact, the child of the machine shop.

The census of machine tools in Latin America under pre-war conditions shows that 39.3 per cent. thereof were made in the United States and 43.2 per cent. in Great Britain—a total of 82.5 per cent. having been made to the English system, while the remaining 17.5 per cent. were made in France, Belgium and Germany and to the metric system.

In other words, Latin American factories have shown their preference for machines made to English over those made to metric measures in the

[1] This census was taken by Mr. O. P. Hood, a representative of the American Machinist, who spent 18 months in South America for that purpose.

ratio of nearly 5 to 1. Knowing these facts as they do, does the reader think that our manufacturers of machinery will follow the advice of these well-meaning gentlemen who have no knowledge of the industry but who tell us that Latin America will not buy our machinery unless made to metric measure? Contrasting the facts with this claim, how much respect can you have for the knowledge of those who make it?

THE VERDICT OF MECHANICAL INDUSTRY

Next, I wish to point out that while the system has been repeatedly adopted under high hopes by industries in the United States and Great Britain, it has not made good its promises.

Twenty years ago, the Library Bureau was the star example of the progress of the system in this country. At the foundation of that industry the system was adopted for the manufacture of its products and there is on file in this office a statement made by a representative of that organization before the House of Representatives Committee on Coinage, Weights and Measures in 1906 in which the system was extolled to the skies and its supposed advantages set forth.

Nevertheless, after thirty years use, the system was abandoned by the Library Bureau, which now manufactures its products to the English system. A similar example is found in Great Britain where in the decade of the 90's the Willans & Robinson Company of Rugby was organized for the production of the Willans high speed engine for which the metric system was adopted.

While continuing the system for the production of this engine, because of the difficulty of a change and the necessity of continuity of production, the system was, after 20 years, abandoned for all new work, Willans & Robinson summarizing their experience in these words:

"We are satisfied that the adoption of the metric system has cost us a great deal in gages and special tools without adequate return."

Similarly, the Ericsson Manufacturing Company of Buffalo, New York (manufacturers of the Berling magneto), report that while ten years ago they used the system exclusively, they have now abandoned it.

The pioneer American watch factory—the Waltham factory—adopted the system early in its history. The Waterbury (now the Ingersoll) Works was established by men from the Waltham Company, who carried the system with them, but beyond that the influence of the Waltham example has not gone, all other American watch factories following the English system. Similarly, the pioneer makers of steam boiler injectors (William Sellers & Co.) adopted the system for that product, but none of their competitors has followed their example, all other makes of injectors being to the English system.

In the cases of watches and injectors, would not the advantage of the system, if it had any, have led to its use by others than the pioneers and is not the fact that others have not used it satisfactory proof that it has

no such advantage? Moreover, William Sellers & Company, who adopted the system for this purpose about 1860 and thus have a longer experience with it than any other American manufacturer, now say:

"Our experience with the metric system, extending over 50 years, does not encourage us to extend its use beyond the borders of the shop and the class of work for which it was originally started."

Another example is found in the optical industry. When, a quarter of a century ago, the making of optical instruments received its great impetus in this country, it was found necessary to import skilled workmen from Europe for the grinding of the lenses. Those workmen had learned their calling in the metric system in which all their formulas and working data were embodied and they naturally continued the use of the system here. It is, however, a striking fact that, except the lenses, which, numerically, are a small part of optical instruments, such instruments are made to the English system. We thus have two systems in use side by side in the same factories, and is it not clear that if the metric system possessed the advantages claimed for it, those advantages would have led to its adoption for the remaining parts of optical instruments?

It is to be noted, moreover, that we are now discussing scientific apparatus which, although made chiefly to the English system, is accepted by scientific men as entirely satisfactory for their purposes. This being the case, by what right do these men claim that others will not accept machinery unless made to the metric system?

Still another case in which, after an initial trial, the system was not found to justify the effort found necessary to use it is found in the chemical industry of the Solvay Process Company of which the drawings used in the construction of the first plant came from Belgium and were in the metric system. The Solvay Process Company write:

"As the workmen in this country were not used to these measures, it became necessary to translate them into the foot and inch system. In many cases this was done by using 40 inches for the meter which gave even inches. We have stuck to the foot and inch for measurements because it was too much of a task to educate all of our workmen to the other system."

THE VERDICT OF MANUFACTURING CHEMISTS

Among the leaders in the movement for the adoption of the metric system are the laboratory chemists who tell us that, in their work, the system is universal.

The replies to the questionnaire which is the subject of Chapter III include nineteen from chemical manufacturers (page 43) not one of whom makes any use of the system whatever. Is it not clear that if the system possessed the advantages claimed its use in the laboratories would have led to its use in some of the manufacturing departments? It is for the laboratory chemists to convert their own people before attempting to force this thing on other manufacturers.

CHAPTER VIII

"SIMPLIFYING" OUR WEIGHTS AND MEASURES

The chief criticism of the English system is that it has too many ratios and that they are bad ratios, and we are urged to adopt the metric system in order to do away with them and introduce the single and simple ratio of ten.

If our experience is to repeat that of other metric countries, we will, after the adoption of the metric system, have in use side by side the pound and the kilogram and we must have the ratio between those units. Moreover, we will use this ratio far more than we now use the ratio between the pound and the ounce. Things that we need in small quantities are bought by the ounce and things that we need in larger quantities, by the pound. The two units are almost never mixed and conversions from one to the other are seldom made. On the other hand, the pound and the kilogram will be used for the same purposes and conversions between them will be frequent. For example, the pound is the universal engineering English unit of force and weight as the kilogram is the corresponding metric unit and conversions between them will be of constant occurrence.

In the same manner we will have frequent occasion to use the ratio between the inch and the millimeter, the square inch and the square centimeter, the foot and the meter, the square yard and the square meter, the mile and the kilometer, the square mile and the square kilometer, the quart and gallon, the liter, the bushel and the decaliter, the acre and the hectare, etc.

None of these ratios appear in either system, but all are essential parts of a dual system, and all will remain as parts of our system of weights and measures so long as the English units continue in use.

In addition to the above, we will have another class of ratios—those between compound units. If the English units are to continue in use, we must have, for example, the ratios between the pound per square inch, and the kilogram per square centimeter, the foot-pound and the kilogram-meter, the pound per foot and per yard and the kilogram per meter, the pound per mile and the kilogram per kilometer, the pound per cubic inch and the kilogram per cubic centimeter, the foot per minute and the meter per second, the mile per gallon and the kilometer per liter, the bushel per acre, and the hectoliter per hectare, and so on without end.

Circular No. 47 of the Bureau of Standards on Units of Weight and Measure contains 45 pages of conversion tables between the English and metric systems.[1] What is to be thought of the addition of these tables as a preparatory step toward the "simplification" of our weights and measures? And once we have adopted the metric system, we will only get rid of these tables by getting rid of the English units. Is it not clear that the whole matter is bound up with the disappearance of the old units, and is it not clear from Chapter II that twenty attempts to bring about that very thing, extending through more than half a century of time, and, collectively, covering a continent have resulted in grotesque failure? What more can be asked and what more can be given as an absolute demonstration?

[1] Even these tables are far from complete. The author has searched them for many equivalents which are not to be found therein.

CHAPTER IX

THE METRIC SYSTEM IN EVERY DAY LIFE[1]

Probably ninety-nine out of every hundred people you meet on the street would look on you with amazement as one who had wandered far from the path of reason and commonsense if you should tell them that there was a well organized movement among scientific men generally to secure legislation at Washington, changing the established ideas of everyone in this country as to the weight and measure of everything. And yet you would be telling the truth and the ninety-nine would be mistaken ones. This agitation, which has been going on for years, has acquired new vigor, since the war began in 1914, and is now under full headway.

Furthermore, this scheme for the compulsory change of the country's weights and measures is endorsed by high officials of the Government, the United States Section of the International High Commission at Washington, of which Sec. McAdoo is chairman, and Mayor Peters of Boston, Asst. Secy. of the Treasury Rowe, and John H. Fahey of Brookline are members having passed a resolution calling for the exclusive use of the metric system in the United States.

A FEW EXAMPLES

Let us see what this means. A person standing 5 ft. 10 inches becomes 1778 millimeters tall, and without any change in height. A mile a minute or 60 miles an hour becomes 1.609 kilometers a minute or 96.54 kilometers an hour, and without any change in speed. A town lot 60 ft. front and 120 ft. deep, with an area of 7200 sq. ft., becomes 18.29 meters front and 36.58 meters deep, with of area of 668.9 square meters, and without any change in size. Nine thousand pounds of coal at $11 a ton plus 40 cents for carrying in, costing $51.30, becomes 4082 kilograms at 12.12½ per tonneau plus 44 cents for carrying in, and costs the same amount, $51.30, unless the dealers change the prices to convenient figures, say $12.25 per tonneau plus 45 cents for carrying, for no one imagines they would reduce prices, and then the coal bill would be larger. Eight thousand cubic feet of water at 12 cents a hundred, costing $9.60 in Brookline, becomes 226.53 cubic meters at 4.237 cents a cubic meter, after the water meters had been changed from feet to meters, unless the town revises the prices, probably upward, to easy figures.

[1] By Mr. Samuel S. Dale.

All the standards of the innumerable transactions at retail would be changed. Dress goods at 50 cents a yard become 54.7 cents a meter until the price is raised to an easy figure. A bed sheet 2½ yards long becomes 228½ centimeters without any change in length. A man wearing what is now a No. 16 collar will wear a No. 40½ collar by the centimeter size and without any enlargement of his neck. A lady who now wears a No. 4 shoe will have to call for a pair of No. 25½ when she orders a new pair by the scientific scale. A pound, say, of butter at 90 cents, becomes .454 kilogram at $1.98 a kilogram. It would soon become $2.00 a kilogram. A quart basket of berries measuring 67 cubic inches will shrink to a liter basket measuring 61 cubic inches, and we may be sure the dealers will consent to this without any change of price. An 11-ounce can of beans becomes 312 grams; an eight-ounce can of salmon, 227 grams; a 13-ounce can of tomatoes, 369 grams: until the cans are all changed to convenient sizes and the prices revised, upward, of course, to convenient figures.

All the screw threads in the country will have to be changed. The new couplings for fire hose and for air-brakes will not fit the old and must be changed all at once if fire losses and railroad accidents are not to be the result of this scientific scheme. Then there is the indescribable confusion by the use of the new screw-threads that will not fit the old gas, water and steam pipes and fittings.

These illustrations of the working of the "scientific" program of weights and measures could be continued indefinitely, for it affects everybody and everything, but I have given enough of them to show into what an extreme of confusion the affairs of the American people will be thrown if the scientists and certain officials have their way. And all this bedevilment of our affairs without any compensating advantage, for no one has shown or can show the slightest benefit from the change, say in the typical cases I have given, for example.

THE REASONS GIVEN FOR CHANGING

When we ask why the change should be made, the scientists tell us the meter is nearly one-forty millionth of the distance around the earth by way of Paris, the North Pole and the South Pole, that the metric system is the best and its use is sure to be universal, that it will help our foreign trade and above all that it is scientific. The boys and girls come out of the schools believing all this "because my teachers said so." The scientists and pedagogues use it in their laboratories and text-books, and have decided that everybody else should use it for all other purposes. Their plan is to jam the thing through by the weight of mere authority and without consulting the millions of people who have far more at stake than they have.

A proposal to make even a slight change in the regulations for the sealing of weights and measures in the city of Boston would undoubtedly and properly receive long and careful consideration in the full light of publicity by the Mayor of Boston before he gave it his approval. And yet the same Mayor will attend a meeting of the International High Commission at Washington, of which he is a member, and allow without protest the passage of a resolution without previous publicity and without adequate consideration, calling for a complete change to the metric system of all the weights and measures of the United States in order to increase our foreign trade, stamping that revolutionary measure with the approval, not only of the Mayor of Boston, but of some of the highest officials of the Federal Government.

THE GROCERY TRADE

Great trades, such as the grocery business are misrepresented as favoring this change. For example, Fred R. Drake, a wholesale grocer, of Easton, Penn., recently told the American Chemical Society of Easton that the compulsory adoption of the metric system has been approved by the wholesale grocers' association of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut. How much the grocers of New England know or care about the metric system can be learned by asking say the first 25 grocers, wholesale or retail, that you encounter in this section of the country. The pro-metric sentiment among the American grocers is a myth. The agitation is the result of the efforts one man, Mr. Drake, who gets pro-metric resolutions passed because the grocers know little and care less about the thing.

Unless the public is aroused and makes its will known the plot will succeed. If the scientists are so anxious for uniformity, let them adopt the standards of the people, for the scientists are few and the people are many. Our foreign trade seems to be growing as it is. If the metric system is scientific, let it remain so. If it is bound to come, let it come on its merits and let it go at that. But let us not allow any scientific clique, and group of loose-thinking officials or any Congress to place on the statute books a law punishing by fine or imprisonment or both the measuring of cloth by the yard, land by the foot, the weighing of coal by the ton, ice by the pound and beans by the quart. Has officialdom fallen bodily under the pseudo-scientific spell? Is there not one public official who will stand for the people against the scientific lobby?

CHAPTER X

THE METRIC SYSTEM IN PRIMARY EDUCATION

At a hearing of the House of Representative's Committee on Coinage, Weights and Measures, of the Fifty-seventh Congress, the Director of the Bureau of Standards said: "Careful estimates by experienced educators place the time saved by the adoption of the metric system from two-thirds to one year in the life of every school child." The statement was repeated by Dr. A. E. Kennelly in the *Popular Science Monthly* for February, 1905, and again by Dr. Jos. V. Collins in the *Scientific Monthly* for December, 1915, and it has, in fact, become an accepted and stock statement of the metric party both in this country and Great Britain. We are never told when, where or by whom the estimate was made, nor are the data on which it is based made public.

The schools of New York city form the largest system of schools on earth in which a uniform plan of work is followed, and the curriculum of these schools supplies data for calculating—not estimating—the time consumed in the study of denominate numbers and weights and measures. Herewith is given the official tabular statement of that curriculum as issued August 2, 1913, and reissued June 25, 1915.

	1st year minutes per week	2d year minutes per week	3d year minutes per week	4th year minutes per week	5th year minutes per week	6th year minutes per week	7th year minutes per week	8th year minutes per week
Opening Exercises	75–75	75–75	75–75	75–75	75– 75	75– 75	75– 75	75– 75
Physical Training, Recesses, Physiology and Hygiene	300–450	180–210	180–210	150–180	90–120	90–120	80–120	80–120
English	570–780	690–780	690–750	600–630	480–630	480–660	400–480	320–480
Electives	.....	.....	.....	.....	.....	.....	.....	200–200
Geography	.....	.....	.....	90–120	90–150	90–150	80–120	.....
History	.....	.....	.....	.....	90–150	90–180	120–200	120–200
Arithmetic	90–125	180–240	150–240	150–300	150–270	150–240	200–280	200–280
Nature Study	60– 90	60– 90	60– 90	60– 90	60– 90	60– 90	.....	.....
Science	.....	.....	.....	.....	.....	.....	80–120	80–120
Drawing	90–120	90–120	90–120	90–120	90–120	90–120	80–120	80–120
Sewing or Constructive Work	30– 30	30– 30	60– 60	60– 60	60– 60	60– 60	.....	.....
Shopwork or Cooking	.....	.....	.....	.....	.....	.....	80– 80	80– 80
Music	40– 60	40– 60	40– 60	40– 60	40– 60	40– 60	40– 80	40– 80

TABULAR STATEMENT OF THE CURRICULUM OF THE ELEMENTARY SCHOOLS OF NEW YORK CITY

This is a maximum and minimum time table so arranged that a principal may devote, to any subject, the maximum or the minimum time or any gradation between them. The number of minutes per week comprised in the school sessions is 1,500, that is, five days of five hours of sixty minutes each ($5 \times 5 \times 60 = 1{,}500$). The school year comprises forty weeks and $40 \times \frac{90}{1{,}500} = 2.4$ weeks is the minimum time spent on arithmetic during the first year, while $40 \times \frac{125}{1{,}500} = 3.333$ weeks is the maximum time for that year. In the same way we may obtain the time to be charged to the subject for the other years and add them up thus:

Year	Minimum	Maximum
1	$\frac{90}{1500} \times 40 = 2.4$ weeks	$\frac{125}{1500} \times 40 = 3.333$ weeks
2	$\frac{180}{1500} \times 40 = 4.8$ weeks	$\frac{240}{1500} \times 40 = 6.4$ weeks
3	$\frac{150}{1500} \times 40 = 4$ weeks	$\frac{240}{1500} \times 40 = 6.4$ weeks
4	$\frac{150}{1500} \times 40 = 4$ weeks	$\frac{300}{1500} \times 40 = 8$ weeks
5	$\frac{150}{1500} \times 40 = 4$ weeks	$\frac{270}{1500} \times 40 = 7.2$ weeks
6	$\frac{150}{1500} \times 40 = 4$ weeks	$\frac{240}{1500} \times 40 = 6.4$ weeks
7	$\frac{200}{1500} \times 40 = 5.333$ weeks	$\frac{280}{1500} \times 40 = 7.466$ weeks
8	$\frac{200}{1500} \times 40 = 5.333$ weeks	$\frac{280}{1500} \times 40 = 7.466$ weeks
	Total, 33.87 weeks = 7.8 months	52.67 weeks 12.2 months

We thus find that the time consumed in the study of the entire subject of arithmetic does not greatly differ from the saving which the metric party assure us would result from the omission of denominate numbers and weights and measures, and no one living can obtain a different result from these data.

In order to determine the time consumed by denominate numbers and weights and measures we have consulted a progressive series of text books on arithmetic[1] which were especially prepared to suit the very

[1] The Pupil's Arithmetic, by J. C. Byrnes, member Board of Examiners, Department of Education, New York; Julia Richman, District Superintendent of Schools, New York and J. S. Roberts, Principal of Public School 62, Manhattan, New York.

detailed requirements of the New York Board of Education. The number of pages devoted to denominate numbers and weights and measures were counted (omitting those devoted to the metric system and to money) and then compared with the total number of pages. Assuming the time consumed by a subject to be in proportion to the number of pages devoted to it, we obtain definite data for the time devoted to denominate numbers and weights and measures.

In the later pages of these books considerable space is given to algebra and these pages have been subtracted from the whole before making the comparison. Dividing the pages given to denominate numbers and weights and measures by the total number of pages remaining after the subtraction, we find the former to be 6.4 per cent. of the latter and, multiplying the time given to arithmetic by this percentage, we find for the time consumed by denominate numbers and weights and measures as follows:

Mimimum	Maximum
$33.87 \times .064 = 2.2$ weeks.	$52.67 \times .064 = 3.35$ weeks.

In view of the different aptitudes of pupils we have here as definite figures as are possible for the saving of time that would follow the disappearance of our present system and the substitution of the metric system. The metric party does not, however, even suggest that all of our present system shall disappear. There is no hint that the division of the circle into degrees, minutes and seconds, the division of the year into months, weeks and days and of the day into hours, minutes and seconds shall be changed.

Not only must these tables still be taught but under these conditions we would still have the subjects of interest and discount involving the divisions of the year, longitude and time connecting the divisions of the circle with those of the clock dial and, should the Shafroth bill be passed, we would have our old land measure, for the survey of the public lands is expressly exempted from the provisions of that bill.

Moreover, surveyors, draftsmen and mechanics must continue to deal with angles and with the units by which they are measured, and with these units all must be acquainted. Clearly, these subjects must still be taught and with them denominate numbers of which they are examples. Clearly, also, the time required for this work must be subtracted from what we have found above to get the net saving. We shall make no effort to determine the remaining modicum of saving, for, certainly, the case has been made sufficiently ridiculous already.

During the transition period both systems must be taught and there would be no gain. If, as all know, the metric system is not now taught effectively, more time must be given to it and the net result would be a loss.

When the investigation of the weights and measures of Latin America

(Chapter II) was in progress, the author addressed the commissioners of Education of many Latin American countries and asked for copies of the school text-books on arithmetic used in those countries. In reply books were received from two countries only—Uruguay and Colombia. Uruguay "adopted" the metric system in 1862 and Colombia in 1853 but these books show that the Spanish system of weights and measures is still taught in the schools of both those countries.

CHAPTER XI

LEARNING THE METRIC SYSTEM

The simplicity of the metric tables leads the metric party to assert that the metric system may be learned in an hour, or, at the most, in an afternoon. When one has learned that ten milligrams make a centigram, ten centigrams make a decigram, ten decigrams make a gram, and so on to the end, how much has he learned? Just as much and just as little as he would learn in committing to memory the pronunciation of the same number of words from a foreign language without their meanings. Until one has acquired the faculty of visualizing values in the metric units or of thinking in the metric system, as the expression is, the learning of the tables leaves in the mind nothing but a meaningless collection of words. Just as a language is not learned until one is able to think in it, so the metric system is not learned until one can think in metric units.

It is no longer necessary to speculate regarding the time necessary to acquire this faculty, as we have on record the results of experience and from metric sources.

RESULTS OF EXPERIENCE

When the Willians & Robinson Works, of Rugby, England, was organized to manufacture the Willans engine, the metric system was adopted for the engine. No more favorable opportunity for the experiment ever existed, as both works and engine were new and without awkward precedent or practice to interfere.

After ten or twelve years' use of the system the chief draftsman of those works, Mr. E. R. Briggs, read before the Rugby Engineering Society a paper on the experience of the works with the metric system, in which paper this phase of the subject was covered. Mr. Briggs had, of course, been obliged to acquire this faculty, and he had seen many, both draftsmen under his immediate charge and others, similarly situated. He wrote as an avowed metric advocate, thus giving an added value to the following statement from his paper:

"There are men who, by application to the values of the units, have been able *in the short space of* 12 *months*, or even less, to think not only in millimeters and kilometers but also in compound units, such as kg.-sq. cm., m.-sec., etc.; while there are men who, although in daily contact with the system, have hardly taken the trouble to think even in millimeters in as much as five years."

Clearly, the effective learning of the system involves more than memorizing the names of the units and the meanings of the prefixes.

Next we have the experience of the Library Bureau, which was formerly the star example of the adoption of the metric system in this country, and who after thirty years' experience with it have now abandoned it and write:

"Our draftsmen and mechanics failed to make any attempt to familiarize themselves with the metric system, but simply translated the metric dimensions into English inches or fractions thereof, and worked accordingly. I do recall, however, having known one man connected with Library Bureau in former days who was inclined to brag that he had mastered the metric system sufficiently so that he could actually think in it as well as he could in feet and inches, but I take it that his was a very rare case."

Another example is found in the experience of the Ericsson Manufacturing Company, who manufacture the Berling magneto and who write:

"As a matter of fact, ten years ago we used the metric measures in this plant exclusively, but owing to inability to get American mechanics who could use the metric system, we found it necessary to shift to the English measures and they are now used exclusively by us both for our product for domestic and export manufacture."

Still another example is found in the great chemical industry of the Solvay Process Company of which the drawings used in the construction of the first plant came from Belgium and were in the metric system. The Solvay Process Company write:

"As the workmen in this country were not used to these measures, it became necessary to translate them into the foot and inch system. We have stuck to the foot and inch for measurements because it was too much of a task to educate all of our workmen to the other system."

Finally, we have the experience of Captain Mahan who said before the Société des Ingénieurs Civils de France:

"Although he is an earnest partisan of the system, which he has used freely for thirty years, he always finds difficulty in thinking in the system. Stating resistances in kilogrammes per square centimeter conveys no meaning to his mind; it is necessary to convert the expression into pounds per square inch."

COMPOUND UNITS

Captain Mahan's reference to pounds per square inch opens up the subject of compound units, which are always with us, and by which term is meant two simple units connected by the word *per* (cents per pound, dollars per ton, miles per gallon). All price units are of this kind. Such units include at least two simple units and often three or more (pounds of coal per horse-power-hour, cents per ton-mile). They are higher mental concepts than simple units and of correspondingly greater difficulty in

revision. Clear conceptions of the values of simple metric units do not help in forming conceptions of values of compound units. Thus, clear concepts of the values of the centimeter and kilogram leave us in the dark with respect to the metric unit of work, the meter-kilogram and its relation to the English unit of work, the foot-pound.

If one is told that an automobile tire is inflated to a pressure of 75 pounds per square inch, he has a definite idea of the pressure—whether it is too little, too much, or about right. How definite an impression does he get from the expression 7 kilograms per square centimeter? If he is told that a certain field yields 20 bushels of wheat per acre, a definite meaning is attached to the words, but how clear an idea does he get if told that the yield is, say, 50 decaliters per hectare? Is $1.00 per stere a high or a low price for firewood? Are potatoes, apples, wheat or corn at 50 cents per decaliter cheap or dear? Would you, kind reader, or would you not buy pine lumber at $10.00 per cubic meter?

This sense of values expressed in our standard units is the insensible acquirement of a lifetime and the above expressions indicate what is before us before we have learned the metric system. A few commodities, like eggs, are sold by count, and of a few others like clothing, the price does not depend upon the size, but probably 90 per cent. of the purchases we make are based upon units of measure and involve this sense of price values which must be re-learned by every American man, woman, and child. Until we have acquired a new sense of price values for everything we buy, we will never know, when making a purchase, whether we have before us a bargain or a swindle.

CHAPTER XII

THE METRIC SYSTEM IN MANUFACTURING

The outstanding feature of the application of a system of measurements to mechanical manufacture is the use of a set of defined sizes to the exclusion of others. The sizes shown by the lines upon a scale of inches are those used under the English system, while those shown by the lines on a scale of millimeters are the ones used under the metric system and it is the change from one set of sizes to the other,[1] which is the foundation reason for the opposition to the metric system among manufacturers.

THE VALUE OF STANDARDS

We make infinite effort to standardize mechanical constructions, and when the work is done the standards accomplish their purpose and work with so little friction that we forget the purpose for which they were established. Most of those who oppose the metric system, when confronted with the suggestion of a change, throw up their hands with the remark: "Think of the cost of scrapping our special tools, fixtures, and gages and replacing them with others made to the metric system." While this instinctive objection is of large importance, it represents but a trifling fraction of the value of standardized constructions, as two examples will make clear.

The couplings with which the hose ends of railway car air brakes are connected were standardized, that is, made interchangeable, many years ago at the works of the Westinghouse Air Brake Company. Because of that standardization, railway cars—both passenger and freight—when fitted with air brakes may be made up in trains regardless of the railroads of their origin and transported throughout our country. What would be thought of an estimate of the value of those standardized couplings in terms of the cost of the special tools with which they are made in the works of the Westinghouse Air Brake Company? Is it not perfectly clear that the real value lies in the results which they accomplish, that is, the possibility of interchanging cars between railroads?

As another illustration, consider standardized pipe fittings. Because those fittings are standardized, they are made by the million and may be

[1] The suggestion of the metric parts that we continue to use existing sizes but measure them in millimeters is discussed in Chapter XV, The Metric Equivalent Scheme.

bought at trifling cost in any pipe fitting shop. The piping of a building consists of little more than cutting pipe to length, threading its ends with standardized dies and assembling the resulting pipes with their connections and fittings. Consider the conditions that would obtain when piping a building for steam, water and gas were it necessary to make each fitting for its place and to order, and then ask what part of the real value of standardized pipe fittings is represented by the cost of the taps and dies with which the threads upon the pipe and fittings are made. Additional examples could be given without number, but these two should be sufficient to show that the value of these standards lies in the results which they accomplish and not in the tools with which they are produced. The value of the tools is not many dollars but the cost of the change cannot be found on any inventory nor can it be measured by any scale.

Consider, next, the result of attempting to change the sizes of air brake hose couplings to metric dimensions and the infinite cost and confusion that would follow. Air brake hose couplings are standardized in order to facilitate the interchange of cars and this the present standards accomplish perfectly. Were those couplings changed to metric dimensions no gain would result since the new couplings would accomplish their purpose no better than the old. Similarly, pipe is made to carry steam, gas and water and if our pipe sizes were changed to metric dimensions, the new pipe would accomplish that purpose no better than the present pipe.

In both these matters, what is to be thought of the suggestion of a "gradual change," or of a change "little by little?" What is to be thought of the idea that air brake factories and pipe fitting shops should equip themselves with metric tools and gages as the existing tools and gages wear out?

Is it not clear that these things must not be changed at all? Is it not clear that what we have to find is not a means by which such things may be changed, but a means by which such changes can be avoided?

In view of these illustrations, what is to be thought of the statement by the Director of the Bureau of Standards: "The most serious difficulty of all is that we have learned to think in the old system," or of the one by Doctor Pritchett that "The argument for preservation of old and inconvenient standards rests on no other basis than the inertia of mankind?"

UNIVERSITY OF CALIFORNIA

CHAPTER XIII

THE METRIC SYSTEM IN ENGINEERING

The preceding chapter on The Metric System in Manufacturing will have made clear the necessity for continuing standardized things which will not be changed because they cannot be. We may pass laws for the adoption of the metric system until the crack of doom, but these things will remain as they are. They supply illustrationss that might be repeated to the point of weariness, but they are sufficient, and they point out what we must consider in the event of the adoption of the metric system, namely, the use of that system in connection with standardized things made to English dimensions for the indefinite future, for the simple necessity of continuity makes the continuance of the existing sizes of standardized things imperative. We must, therefore, in engineering consider not the hypothetical condition of the metric system standing alone, but the actual condition of the conjoint use of both systems—one in materials of construction and the other in engineering calculations.

Let us, therefore, consider the conditions to be met after the metric system has been adopted but while existing structural standards continue in use. To make this clear, some of the simplest possible illustrations have been selected in order to point out a universal principle.

SIMPLE, PRACTICAL EXAMPLES

Take the simplest possible case—finding the size of a bar of steel to carry a given load in tension. We place the load on one side of an equation of which the other side includes as factors the required area of the bar, the tensile strength of the material and the factor of safety. We write the load in kilograms and the tensile strength in kilograms per square centimeter and find the required area of the bar in square centimeters, to be at once confronted with the fact that all American merchant bar is rolled to diameters in inches. We, like metric countries, have plenty of tables of areas, but in all cases they connect diameters and areas in the same system of units. With either system used alone we would, after finding the area, take the diameter directly from a table; but we must now find the diameter in inches from the area in square centimeters by calculation, until such time as someone has prepared and printed a transition table giving diameters in inches and areas in square centimeters, or, by first finding the diameter in millimeters and then converting the result to inches.

An alternative procedure is possible. The formula might be altered into a transition formula giving the tensile strength in kilograms per square inch and the area in square inches. We could then use existing tables of areas, but in addition to the transition formula we would need transition tables giving strength in kilograms per square inch. Such tables must be prepared and printed before this procedure is feasible. Whatever the procedure, we shall at the end have the same result—that is, the same load and the same bar, to get which we have discarded existing tables and made the calculations which the tables have been prepared to avoid.

TECHNICAL LITERATURE MUST BE REWRITTEN

This case has been gone into in, perhaps, tedious detail, because it illustrates in the simplest possible way a universal principle: Whenever basic quantities—loads, powers, velocities, pressures, capacities, etc.—are expressed in one system of units while commercial materials are made to, and their properties are recorded in, another, we have a conflict in every application of one to the other. Existing formulas, English or metric, do not fit, and existing tables do not apply. To suit this condition, our technical literature must be rewritten from the beginning in transition form for use so long as existing commercial sizes of materials continue in use, to be discarded when, and if, the transition period comes to an end.

Illustrations of this may be multiplied to the point of weariness Suppose we are laying out a belt transmission. The formula for the capacity of belts includes the velocity and width of the belt, with other factors. Our reference books contain charts that give the effects of speed, centrifugal force, thickness, type of joint and arc of contact almost at a glance, but these we must discard and make the calculations which the charts have been prepared to avoid.

With the load in metric units, this calculation gives us the velocity in meters per second and the width in millimeters; but when we take up the matter of pulleys, we find that all pulleys made in this country are to inches of diameter which, multiplied out, give the circumferential velocity in feet per minute, and this result we must equate with belt velocities in meters per second. Ultimately, we must use the pulleys we can buy—that is, of English diameters and widths.

Going farther, we determine the shaft sizes, to be confronted with an applied torque in meter-kilograms equated with the resisting torque of a shaft in inches of diameter, on which the only available information as regards torsional strength is in pound-inches. As before, we need a transition formula and tables giving, in this case, resisting torques of shafts in kilogram-inches, and as before, we get the same result in the end.

Since closeness of fit is not involved, we may still place a belt of metric width on English pulleys, shafts, and bearings; and then, if we are true-blue metric advocates, we will shout from the house tops: "We have adopted the metric system."[1]

Do we calculate the diameter of a pipe or a boiler for a given pressure, it is the same. From the pressure in kilograms per square centimeter we get the stress in kilograms per square centimeter, to be equated with the strength of the material, of which the thickness is in inches, and all available data for strength are in pounds per square inch.

Do we calculate the weight of structures, it is again the same. We have extended tables of the weight of materials in pounds per foot of length; but if we are to use the metric system with these materials, we must have transition tables for I-beams, channels, angles, bars, pipe, sheets, etc., giving weights in kilograms per meter of materials rolled to inches of cross-section.

TECHNICAL TABLES MUST BE RECALCULATED

The matter of the tables is perhaps of even greater actual, though less fundamental, importance than the formulas. Our tables are now so complete and comprehensive that the large majority—in some applications perhaps 80 per cent.—of such problems are solved by direct reference to them, resort to the formulas being had only for occasional cases beyond the range of the tables. All our tables are based on one system of units. We have no tables for a mixture of units; and until someone has been good enough to prepare and print them, we must resort to calculation which the tables were prepared to avoid and, so long as existing materials are used, get the same result in the end. What is gained? What is it all for?

As another illustration consider the most ordinary problem in hydraulics—finding the diameter of a pipe to carry a given quantity of water. Hydraulic tables are remarkably complete, and most such problems are solved by simple reference to them. Using the metric system, we have the head, the velocity and the length of the pipe in meters and the discharge in liters, but the diameter of the pipe is in inches. We have neither formulas nor tables fitting this condition, and again we must calculate and convert, our calculations in this case involving the square root of the fifth power in millimeters of pipe diameters in inches. The

[1] This is not sarcastic, but descriptive of every "adoption" of the system of which I have any knowledge, all such adoptions being partial. The metric enthusiast makes the easy changes. He does not make the difficult ones, but he invariably talks as though he had made them all. He regards the difficult changes that he has not made as not worth counting. If we are to study difficulties, we must study difficulties, the changes which he does not make because he cannot, and does not count because it suits his purpose not to, being the very ones that must be counted.

results of these calculations we now take directly from the tables, and again the final result is the same.

In the foregoing cases we have to deal with repeated conversion of units, which while bad enough, is not all. Let us therefore consider one more everyday case in which even this will not answer—finding the size of an I-beam to carry a given load. Our span is in meters, and our load in kilograms, but the cross-sections of our beams are in inches. What shall we do with the moment of inertia? In the moment of inertia of an I-beam four dimensions enter, two by their first powers and two by their cubes. There is no possible conversion factor between English and metric moments of inertia. Moments of inertia of all common cross-sections in English units have been worked out and tabulated in great profusion, but we cannot use them even by conversion. Until new transition tables of metric moments of inertia of sections rolled to inches have been prepared and printed, every calculation of an English section I-beam for metric loading involves the calculation of the moment of inertia for the cross-section or, as an alternative, the use of English units for the load and span. Which will be done?

A FEW EXAMPLES

Following is a list of a few such tables that will be needed: Square roots of fifth powers in millimeters of pipe diameters in inches; weight of materials in kilograms per cubic inch; board measure; section moduli, radii of gyration and squares thereof and areas of rolled sections; friction head and discharge of pipe; weight of all rolled sections and of rivets, bolts, bars, balls, plates, pipe—cast, welded, cold drawn, etc.; strength of columns and pillars; strength and weight of chain and rope—wire and hemp; weight and other properties of brass, copper and lead pipe and other products of these materials; strength and other properties of timber beams, columns, etc.; properties of boiler and condenser tubes; bursting and collapsing strength of pipe; pipe flanges; flow of air in pipes; all screw-thread and gearing tables; chain-driving tables; the strength of riveted joints; angles when considered as tapers per foot; chord-spacing tables of circles; weights and other properties of all materials made to wire and sheet metal gages; loads on bearings; strength of shafting; strength and deflection of springs; all machine-shop standards—tapers, dovetails, machine parts and details, press- and running-fit practice, etc.; performance and power requirements of machines in endless variety; strength of materials of all kinds and grades; steam-engine and boiler practice from the ground up. But the list is endless. If the reader will open any engineer's reference book and look for a formula or a table (other than mathematical tables, which are universal) that will be useful during the transition period, he will look long before finding one.

Of these two requirements in preparation for the transition period the transition formulas will come first. We will then be in shape to use the metric system, provided we are willing to discard all tables that have been prepared through many decades to shorten, and, in many cases, eliminate calculations, the physical result being the same in all cases and the psychological result the proud and superior consciousness that we are "using the metric system."

We are to discard these devices for saving time in calculations and make the calculations which they make for us, in the cheerful belief that the loss will be compensated with a balance to the good through the magic of the "beautiful inter-relation and correlation of the units." This is the hook which engineers are asked to swallow, and by all that is logical the proffered bait is economy of time in calculations!

Those who are familiar with these problems will recognize that many of them must be solved by successive approximation or trial and error. With the tables we soon find the appropriate size; but when calculation is resorted to, we must calculate and recalculate until a satisfactoy result is found.

All this leads to but one conclusion: So long as existing commercial sizes of materials of construction endure, no sensible man will resort to metric calculations with them more than once.

WHO WILL LEAD THE PROCESSION?

Will the rolling mills lead in this change? For them to do so involves the duplication of sections and assortment of rolls, the doubling of the number of changes of rolls, with the resulting loss of time and the warehouse stocks to be carried. Incidentally, they will recalculate and reprint their tables of the properties of their sections, first in transition form for existing sections and then in metric form for the new sections, supplying also, meanwhile, the existing tables for those recalcitrant engineers who prefer the old and simple way. When it is all done, the new sections will do their work no better than the old, and we cannot look for enthusiasm in that quarter.

The doubling of stocks to be carried is the minimum involved. During the transition period we will have occasion to put English pulleys on metric shafts, and metric pulleys on English shafts, and we will therefore require the follwing pulleys: English bore and rim; metric bore and rim; English bore and metric rim; metric bore and English rim. A pulley manufacturers' warehouse stock now comprises about 10,000 pulleys. The multiplication of this list by four will curb enthusiasm in that quarter.

In pipe fittings the case is equally serious. The new sizes of pipe must be connected with the old, and the most simple fittings—nipples and

couplings—would be multiplied by three and the tees and crosses by not less than six. As before, the new pipe and fittings will carry water, steam and gas no better than the old. These illustrations might be extended indefinitely, but one must stop somewhere.

Shall we then conclude that the change is impossible and therefore not to be feared? That would be as shallow, as stupid and as fatal as the worst of the metric conclusions. Let no one forget that, while a complete change is impossible, a partial change is easy—as easy as going down a toboggan slide—and this partial change is exactly the thing that leads to the welter of confusion of which the above is a picture. Let no one imagine that in the absence of compulsory law he can use it or not as he sees fit. Once here, we must all deal with it and use it, whether we wish to or not. In this matter no man lives unto himself. Every metric stone thrown into our industrial lake is the center of an expanding area of disturbance. If this chapter means anytning, it is that a partial chang spells total confusion and that every introduction of the system is to be fought as the intrusion of an enemy of our industrial life.

No *manufacturing* country has ever attempted to change its weights and measures and the United States and Great Britain are the only such in which the change has been proposed.

France adopted the system before the beginning of the manufacturing era, as did Belgium. Germany adopted it after the Franco-Prussian War of 1870 from which dates her entry into the list of manufacturing countries. Latin American countries are not manufacturing countries.

The manufacturers of United States and Great Britain point out an overwhelming cost and burden due to the adoption of the system and, against their case, not so much as a shadow of a precedent can be cited.

CHAPTER XIV

THE METRIC SYSTEM AND THE SCIENTIST

The adherence of many scientific men to the metric propaganda makes necessary an answer to the question: Why have these men gone so far wrong? The man in the street has merely accepted the endless repetitions of myths and fables and his opinion may be dismissed. From the scientific men, however, we expect something better because he is supposed to speak from knowledge.

The scientific man, like many others, has made the initial assumption that a change in weight and measures by a country may be easily brought about. He had this initial belief and, in his case, he was fortified by the fact that in his own work the change is easy.

In the affairs of modern life there are three leading applications of weights and measures—to industry, commerce and science—which applications are named in the order of decreasing difficulty. In industry we have both the universal psychological difficulty of learning to think in metric units and the still greater physical difficulty of a change in manufacturing sizes. In commerce the physical difficulty, while still present, is nevertheless much reduced, although the psychological difficulty remains in full force. In science the physical difficulty nearly disappears while the psychological difficulty is at its minimum.

Let us compare the task of learning to think in metric units as it appears to the laboratory scientist and the corner grocer. Should this change come to pass, both parties must use the kilogram and learn to visualize values in it or to think in kilograms as the expression is. For this, the scientist must acquire a clear conception of the value of the kilogram and his psychological task, so far as the kilogram is concerned, is then complete.

The grocer must also acquire this conception, but his task is then no more than begun. With the grocer, units of weight are compounded with price units. He buys and sells many things of which the prices are given as so many cents per pound and, stored in the back of his head, is a whole series of such price units, both wholesale and retail, for all the commodities that he sells by weight—this being an important part of his business equipment.

After the metric system is adopted, he must acquire a new sense of price values in cents per kilogram for all of these commodities. If he sells 100 articles by weight, he has 100 times as much of a task before him as

the scientist before he has learned to think in kilograms—indeed, we should say, 200 times, for the grocer must have in mind both wholesale and retail prices.

It is useless to say that he may divide the prices per kilogram by 2.2 in order to reduce those prices to cents per pound because, so long as he has to do that, he has not learned the metric system for he still thinks in pounds.

After the grocer has acquired this new sense of price values, he must then teach his salesman, buyer, bookkeeper and others who are concerned with prices and after they have acquired this new sense of price values, the grocer must deal with his customers. Some of these customers are not very intelligent while some are stupid—so stupid that they are unable to understand why butter at $1.10 per kilogram is a better purchase than the same butter at 50 cents per pound. Other customers, again, are indifferent and can see no reason for all this pother for no particular purpose, while still others are hostile and object to recasting all their ideas of values not only for groceries, but for everything they buy.

Some of these hostile customers tell the grocer that when he names prices in these strange units, they cannot tell whether he offers them a bargain or a swindle, and they tell him very plainly that unless he can offer them goods in terms that they understand they will go to other grocers who will.

Were we to compare the task of the scientist with that of the manufacturer, we would find an even greater difference than that between the scientist and the grocer, but this illustration seems sufficient to show that the scientist has no right to speak for the corner grocer.

CHAPTER XV

THE METRIC EQUIVALENT SCHEME

The opposition to the metric system has at least accomplished one object. The metric party have come to realize that the task of changing the set of sizes now in use from those shown on English to those shown on metric scales, tape lines, etc., cannot be ignored, and they now propose that we do not change them but continue to use existing sizes and measure them in metric units. This idea, while not new, has been put forward with increasing frequency of late, and it has now become the official plan of the metric party.

In a newspaper interview, the Secretary of the American Metric Association said: "Just as our Government experts have pointed out, whatever is manufactured must be exactly the same size or weight as before. It is merely a matter of a new term of expression." In order to show the absurdity of this plan, it is only necessary to try it.

EXAMPLES FROM REAL ESTATE

New York and many other cities are laid out in building lots measuring 25 × 100 feet of which mere inspection shows the area to be 1500 square feet. Using the "new term of expression," that is metric units, for these dimensions, we have for a city building lot:

Front width	7.62002	meters
Depth	30.48006	meters
Area	139.35	square meters

Does the reader consider the metric equivalents improvements on the English figures or does he think that the former will ever be adopted, except under compulsion, in the purchase and sale of city real estate?

For about a century the public lands of the United States have been laid out in townships of 6 miles square or 36 square miles area. Each township is divided into 36 sections of 1 mile square and 1 square mile, or 640 acres area, and each section into quarter sections of ¼ mile square and 160 acres area. One and a quarter billion acres have been thus surveyed, the quarter section forming the familiar homestead area. Again using the "new term of expression" for these quantities we have the following comparisons:

	English figures		Metric figures	
	Side	Area	Side	Area
Township.....	6 mi.	36 sq. mi.	9.6561 km.	93.24 sq. km.
Section.....	1 mi.	1 sq. mi. 640 acres	1.6093 km.	2.58999 sq. km. 258.99985 hectares
Quarter section....	¼ mi.	160 acres	0.4023 km.	64.74996 hectares

THE "NEW TERM OF EXPRESSION" APPLIED TO WESTERN FARM LANDS

When confronted with these absurd figures the metric party immediately hedge by explaining that they will endure only through the transition period and disappear when the metric system is finally adopted, but how the close of the transition period is to change the size of city building lots or of the townships, sections and quarter sections of the Great West they do not explain. These sizes must be changed or these expressions will endure for all time.

Again does the reader regard the metric figures an improvement and does he think they will be used in buying and selling western farms?

The above are the simplest possible illustrations but they show what always happens when standards that have been developed in units of one system are measured in those of another. The change always results in figures which are worse than those with which we started, impossible to memorize and meaningless to those who attempt to use them.

EXAMPLES FROM THE MACHINE SHOP[1]

Next, let us apply the "new term of expression" to screw threads. It should here be noted that, the inch being larger than most pitches, we commonly express pitches as so many threads per inch, whereas, the millimeter being smaller than most pitches, metric pitches (in the few cases in which they are used) are expressed by giving the number of millimeters between threads. This transposition to conform to usage has been made in the accompanying table.

Suppose we are to cut a screw of ten threads per inch, the lead screw of the lathe having four threads per inch. We see at once that the ratio of the change gears is $\frac{10}{4}$ or 2½ to 1. Using the "new term of expression," the figures become $\frac{6.35}{2.54}$ and the ratio, which is obvious at a glance with the English system, requires calculation to find with the metric system. Worse yet, whatever thread we want, the index plate of the lathe will give, without calculation, the required gears for the English pitch, while no lathe in the world has an index plate reading for the "new term of

[1] See also "the new term of expression" as applied to standard shafting, page 181.

expression," gears for all of which must be calculated. This is one way in which the metric system brings about "economy of time in calculations."

English dimensions		Metric equivalents	
Diameter, in.	Pitch, threads per inch	Diameter, mm.	Pitch, mm.
¼	20	6.35	1.27
⅜	16	9.53	1.59
½	13	12.7	1.96
⅝	11	15.88	2.31
¾	10	19.05	2.54
⅞	9	22.23	2.82
1	8	25.4	3.17
1¼	7	31.75	3.63
1½	6	38.1	4.23
1¾	5	44.45	5.08
2	4½	50.8	5.64

THE "NEW TERM OF EXPRESSION" APPLIED TO SCREW THREADS

Next, let us apply the "new term of expression" to gear cutting. Here we have a similar difference of practice, which is mentioned not to discuss, but to point it out. In the English system, the diametral pitch is the number of teeth divided by the pitch diameter, while in the metric system, the module is the diameter divided by the number of teeth. Making this transposition as before, the "new term of expression" for a few diametral pitches is given in the accompanying table.

English diametral pitch	Metric equivalent module
4	6.350
5	5.080
6	4.233
7	3.628
8	3.175
9	2.822
10	2.540
11	2.309
12	2.117

THE "NEW TERM OF EXPRESSION" APPLIED TO GEAR TEETH

In place of the simplest possible series of integral numbers, we have a set of decimals which no one can remember, and three decimal places are necessary if the results are to be sufficiently accurate. Considering calculations again, with the English system, the number of teeth is found by multiplying the pitch by the diameter, while with the metric system, the number of teeth is found by dividing the diameter by the module, *both fractional in all cases.* Taking identical examples, we have

English System	*Metric System*
8 pitch × 6½ in. dia. = 52 teeth	$\frac{165.1 \text{ mm. dia.}}{3.175 \text{ module}} = 52$ teeth

To appreciate the point, the reader should make the actual division with pencil and paper. With both procedures, the result is identically the same gear and again we see how the adoption of the metric system will lead to "economy of time in calculations."

The reader should here remember that the above are simple illustrations of the officially adopted plan of the metric party and, moreover, of a plan which has the endorsement of the Bureau of Standards.

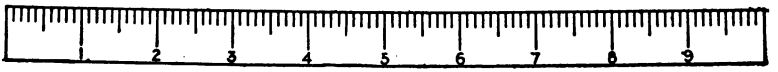
If the metric system is adopted one of two things must be done—such figures as these must be used or existing standardized sizes must be abandoned and the metric sizes be substituted.

THE METRIC PARTY HEDGE

When confronted with these absurd figures the metric party again hedge and assure us that they will endure only through the transition period and disappear when the metric system is finally adopted. They thus confess their ultimate plan to be to make changes which at first they disclaim, the disclaimer being nothing but a subterfuge to induce the public to embark on this program. Under pretense of not making changes their real plan is merely to postpone them and meanwhile, through false pretenses, obtain the passage of a law which will make them necessary.

THE CASE OF THE DRAFTSMAN

Let us consider one more application of the plan. When reduced to practice it involves that draftsmen and mechanics will be required to use a set of sizes that are not given by the lines on the scales (that is, the metric scales) from which they are taken. That is to say, instead of taking from the scales the sizes shown by their lines, intermediate sizes are to be taken by estimation.



Metric scale for laying off English dimensions.

Will the reader please imagine himself a draftsman at work in an office where drawings are being made for products "exactly the same size as before" but using the "new term of expression." He has before him a draftsman's metric rule as shown in the accompanying illustration and let him attempt with it to lay down a few such dimensions as ⅝, 1¼ and 2½ inches. The attempt, without explanation, will be suf-

ficient to show both the hopelessness of the plan and the ignorance of those who propose it.

CLAIMING BOTH ENDS OF THE ARGUMENT

Offering the "new term of expression" in one breath and withdrawing it in the next when the results of its application are shown is an attempt to claim both ends of the argument. When we show them that the change of sizes is impossible, they tell us we will not change them but use millimeter equivalents. When we show them that millimeter equivalents are hopeless, they tell us we will not use them but change the sizes. The attempt to reason with such people is hopeless.

Were this plan feasible other countries would long since have adopted it and their old units would have disappeared just as ours are expected to disappear. No such practice can be found anywhere and for examples we cite all Latin American countries of which the practice is given in Chapter II.

CHAPTER XVI

THE METRIC SYSTEM AND THE SAVING OF TIME IN CALCULATIONS

Of all the myths associated with the metric argument, none is more insistently set forth than that its adoption will lead to an important saving of time in calculations.

Like all metric claims this one is based on the tacit assumption that old units are to disappear. This being opposite to the experience of all nations that have endeavored to adopt the system, it is clear that we must consider the conditions that will prevail with a mixture of systems. This has been gone into in some detail in Chapter XIII—The Metric System in Engineering.

A FEW SIMPLE EXAMPLES

Reference to the summaries of information from Latin America, Chapter II, will show that the metric system has made much greater progress there in retail than in wholesale trade. The result is that merchants buy their goods at wholesale by one system of units and sell them at retail by another and we see at once how "simple" the merchants' calculations are.

Further reference to those pages will show that when one erects a building, his building lot is measured by the vara while his mason work is done by the meter, his carpenter work by the pulgada, his painting by the square meter and his glazing by the inch, while his piping is measured in length by the meter and in diameter by the inch and, when he goes to the lumber yard for his lumber, he will buy so many cubic meters of one inch boards.

The reader will see at once how "simple" the builders' calculations are—how simple when he calculates the cubic meters of one inch boards required to lay the floor, how simple when he calculates the cubic meters of 10 by 12 inch timbers required for the frame and, when he determines the velocity of water in meters per second and the discharge in liters through a two-inch pipe, the calculations will be so simple that he will make them with his eyes shut.

A MORE UNUSUAL EXAMPLE

These are the results on simplicity of calculations due to a mixture of systems in a few simple cases. The following example shows the results

in assay calculations in a Mexican smelter. It is supplied by Mr. J. Parke Channing, Past President of the Mining and Metallurgical Society of America and a mining engineer of much experience in Mexico.

"When the ore contains 5 per cent. or more of lead, it is paid for at 1 cent U. S. currency per *pound* when soft Spanish lead is quoted in London at 13 pounds sterling per *ton* at 2240 *pounds*. For each advance or decline of 1 shilling, 3 pence in the London quotation, 1 cent U. S. currency per 100 *pounds* for lead contents will be added or deducted. The ore, however, is weighed and deliveries are made in *kilos* and assays are reported per *metric ton* of 1000 *kilos*. The silver is paid for at 90½ per cent. of the New York quotation, which is in U. S. currency per *Troy ounce*. The gold, however, is paid for at $0.6269 U. S. currency per *gram*. Freight and treatment charges are $24.50 Mexican currency per *ton* of 2000 *pounds avoirdupois*."

THE CLAIM INVERTED

The moment we realize that the so-called adoption of the system means, in reality, nothing more than its introduction, with the continued use of the old system, we recognize that the claim for the saving of time in calculations is not only nullified but inverted and becomes an argument against the system.

THE METRIC SYSTEM CONSIDERED ALONE

It is, however, not true that even in the absence of old units the claim has any foundation. The claim is based on the "interrelation and correlation of the units," of which so much is made and which, while very pretty theoretically, have no application to the commercial and industrial uses of weight and measure. To illustrate the supposed superior simplicity in the calculations of everyday life, the metric party give hypothetical problems to solve. They assume, for example, a distance of so many miles, furlongs, rods, yards, feet and inches, show the number of figures required to reduce this expression to inches and then give corresponding problems in which distances are expressed in kilometers, hektometers, dekameters, meters, decimeters, centimeters and millimeters and show that the expression can be reduced to millimeters by the simple process of properly locating the decimal point. Similarly, they show the amount of work involved in reducing an immense number of inches to miles, furlongs, rods, etc.; and alongside they place an exhibit showing that millimeters may be reduced to kilometers, hektometers, etc., by merely changing the decimal point.

THE CASES OFFERED ARE HYPOTHETICAL

The trouble with these problems is that they are purely hypothetical. No one has them to do—no reader of these pages has occasion to solve such problems outside of the schoolroom or laboratory. With the exception of feet and inches, which are used in combination, although the

tendency is against the practice,[1] quantities are commonly expressed in a single unit. Thus the flow of aqueducts and the capacity of pumping engines and of city reservoirs are given in gallons and the strength of materials in pounds per square inch. Similarly, when we buy small quantities of things at the drug store, we do it by the ounce and its fractions, while if we buy larger quantities at the grocery, we do it by the pound and its fractions—pounds and ounces being, practically, never mixed. Again, we buy milk by the quart, gasoline by the gallon, grain by the bushel and cement by the barrel, but no reader of these pages ever sees the units used conjointly. The civil engineer uses the mile as his long, and the foot as his short, unit of length—these units being divided decimally for the purposes of measurement and calculation—but he seldom or never uses the two in combination. His unit of excavation is the cubic yard, but like the others it stands alone. Reduction, ascending and descending, among these units is among the rarest of problems, and the ratios between them are about the least important things that ever provoked a heated discussion.

Not only is this the method by which these units are used, but it is the manner in which they were intended to be used. Units of different sizes—English and metric alike—are provided in order that those suitable for various purposes may be available. The quart being suitable for the amount of milk commonly purchased, the quart is used for that purpose, while the gallon being suitable for the amount of gasoline commonly purchased, the gallon is used for that purpose. For the same reason the ounce is used for the purchase of drugs, the pound for groceries and the ton for coal. The use of a mixture of units for the same purpose is uncalled for and unnatural, and its appearance in the problems referred to is simply a case of manufacturing evidence to suit the case that it is desired to prove.

This use of units nullifies the argument for simplicity of calculations, and it reduces to insignificance the importance of the ratios between units. For purposes of calculation our units may be divided decimally,[2] as they usually are, when they fall into perfect harmony with decimal arithmetic. When units are used in this way, no discoverable difference in the time required for calculations in the English and metric systems has

[1] Examples of the gradual disappearance of the foot as a unit for the dimensions of machines, are found in the figures for the wheel-base length of automobiles and of locomotive driving wheel tires both of which are always given in inches only. Some of our foremost machine shops have discarded the foot, inches only being used.

[2] The metric party labors under a strange hallucination that they possess a monopoly of decimal arithmetic, and they hail every use of decimals as a concession to their claims. Decimal fractions are of course centuries older than the metric system. So far from inventing decimals, the fathers of the metric system merely attempted to discard other fractions. Metric partisans might as reasonably claim exclusive use of the Arabic notation or of the Roman alphabet.

ever been shown, because none exists. The engineer calculates stresses or pressures in pounds per square inch with absolutely the same simplicity of calculation that he does in kilograms per square centimeter. So, also, the dimensions of structural members are calculated in inches with the same degree of simplicity as in millimeters, and hydraulic calculations in gallons are as simple as in liters.

Regardless of endless iteration and reiteration to the contrary, these statements are facts. The claimed simplicity of calculations is the outgrowth of the "interrelation and correlation of the units." When we confine ourselves to a single unit, there is neither interrelation nor correlation, and the supposed advantage vanishes.

When calculating weights, we multiply the volume by the specific gravity in the metric system and by the weight per unit of volume in the English system, consulting a table for the required constant in either case. There is not a shadow of advantage in either procedure, except when calculating the weight of a tank of water; and in the one field of human endeavor in which this might be of appreciable value (naval architecture) it vanishes in the increased gravity of sea water.[1]

As Mr. A. M. Mattice put it:

"In the drafting room of a manufactory the draftsmen are always computing weights for balances, strengths, and costs. They may use one material instead of another on account of weights. Suppose I have a rail or rod of iron, and its area is 8 square inches. What is its weight per yard? An inexperienced man would multiply by the weight per cubic inch, and finally get it. But all you have to do is to bring your decimal point one place to the right and you have it. Ten times the area of cross section of wrought iron is the weight per yard in pounds exactly. It is not an approximation, but exact. That one little fact is of more importance to the metal manufacturers of this country than the relation between the meter and the volume of fresh water, because it is being used by hundreds where the other is being used by one person."

In commercial transactions no one has shown and no one can show the slightest advantage in the purchase of dry goods by the meter as against

[1] While there is no advantage in either procedure, nevertheless of the units most used for the purpose (the inch and the millimeter) the English unit is the larger and expresses the same dimensions in fewer figures. Above about 4 inches the millimeter always requires at least three figures; and above about 40 inches at least four. This results, in the average case of calculation, in fewer figures with the English system. While this is a fact, it is too trifling a matter to deserve mention here except to counter the grandiose and ridiculous metric claims. The subject is, moreover, of little more than academic interest, as the procedure described is, in practice, used relatively but little. The leading calculators of weights are engineers, architects and shipbuilders. In the case of castings the procedure described is followed, with such balance of advantage as there is on the English side. The weights of the other materials used are tabulated with great completeness in pounds per hundred and per foot of length or area. Actual calculations of the weights of structures are made by the use of these tables, and the labor involved is determined not by the system of measurements used, but by the completeness of the tables available.

the yard, groceries by the kilogram as against the pound, or milk by the liter as against the quart. The claim which one often sees that the metric system would be a protection against short weight is of course absurd. There is nothing to prevent the making and using of short metric with the same facility as short English measures.

Equally absurd are the claims that "calculations in the metric system are two or three times as accurate as in the English system" and that "calculations always come out in even figures in the metric system."[1] After completing his calculations the English designer adjusts his results to the nearest eighth or sixteenth and the metric designer to the nearest tenth, and between these procedures there is not the suspicion of a choice.

[1] The quotations are from an article by Dr. Jos. V. Collins published in the *Scientific Monthly*.

CHAPTER XVII

THE METRIC SYSTEM AND THE ENGLISH LANGUAGE

The ridicule which is heaped upon the English system of weights and measures can be exactly paralleled by similar ridicule of the English language.

Consider its atrocious spelling and pronunciation, its words which are spelled alike and pronounced differently, others which are pronounced alike and spelled differently, and still others which are spelled and pronounced alike but have different meanings. Consider its irregular verbs; its complex rules of syntax, its excessively idiomatic construction, and, especially, its enormously redundant vocabulary, which last is exactly comparable with the redundant units of the English system of weights and measures. Consider the enormous burden which these matters lay upon school children and upon foreigners who have to learn our language. No one can learn this enormous vocabulary as we are told that no one can learn all of the units of the English system. In neither case are we embarrassed because in both we learn what we need and ignore the rest, but the parallel holds.

Let us away with such a "clumsy and cumbersome" method of speech, and adopt the "simple, scientific and logical" Esperanto.

The parallel is exact, except that Esperanto has not made as much progress as the metric system, but someone must be a pioneer in such a movement, and if the French people deserve so much credit for inaugurating the metric system, let us acquire similar credit for inaugurating a new and universal language.

All recognize that to change the language of a country is impossible, while some believe that a change in weights and measures is easy. The main purpose of this volume is to show, by the experience of nation after nation, that here also the parallel holds.

CHAPTER XVIII

OUR ENGLISH WEIGHTS AND MEASURES[1]

It has been proved that established weights and measures cannot be arbitrarily abolished, and that, so far as the United States is concerned, the choice is not between the English system and the metric, but it is between the English system and the confusion of two systems. In addition to that fact it has been demonstrated that, while neither of the two systems is perfect, the English is better adapted to the work of the world than is the metric. And the conclusion of the whole matter is that we cannot change our English weights and measures if we would and we should not if we could.

THE ONLY FEASIBLE BASIS

Instead of discussing these proved conclusions now, let us consider the most significant feature of the weights and measures situation, the fact that our English system has reached such a commanding position throughout the world, and its identity with other natural systems of weights and measures is so great as to make it the only feasible basis for the unification of the world's weights and measures.

THE WESTERN HEMISPHERE

Let us take a look at the situation, beginning with the Western Hemisphere. Spanish and English systems predominate in Latin America and, to a remarkable extent they are identical. Look at the Spanish tables as taught in the schools of Latin America today:

12 inches, 1 foot; 3 feet, 1 yard; 144 square inches, 1 square foot; 9 square feet, 1 square yard; 1728 cubic inches, 1 cubic foot; 27 cubic feet, 1 cubic yard; 16 ounces, 1 pound; 100 pounds, 1 quintal: 2000 pounds, 1 ton.

These multiples are practically the same as the English. As for the size of the units, the Spanish vara, or yard, is an approximation of the English yard, while the Spanish weights, ton, quintal, pound, and ounce, vary only one-half of one per cent. from the corresponding English weights.

So much for Latin America. As for the remaining portion of the Western Hemisphere, it is not necessary to dwell on the impressive fact that the English system is the established and fundamental standard of the United States and Canada.

[1] By Mr. Samuel S. Dale.

THE EASTERN HEMISPHERE

Turning now to the Eastern Hemisphere we find English weights and measure to be the established system in that vast area comprising the British Empire, while in China, English weights and measures are the recognized standards at the treaty ports. Throughout that other vast area known as Russia the linear measures are based on the English inch. The Russian duim is the English inch; the Russian foot is the English foot; the Russian archine is 28 English inches; the Russian sagene, 7 English feet; the Russian verst, 3500 English feet. The Chinese system in use throughout the country is not well standardized, but the standards of weight in most extensive use are based on the ounce (liang or tael), equal to 1⅓ avoirdupois ounces: 16 Chinese ounces make 1 pound (catty); 100 Chinese pounds, 1 picul. Thus the Chinese and English weights are easily commensurable and divided as in the English system. Chinese linear measurements are based on a unit (ch'ih) approximating the English foot, the leading standard being equal to 12.5 English inches.

In Japan the established system of linear measures is based on a foot (shaku), of 11.93 English inches used by artisans, and on a foot of 14.9 inches used for dry goods.

Furthermore, in addition to being established and fundamental or closely identical with the established weights and measures in so large a part of the earth's surface, the use of the English system has been extended to all countries by trade and industry, one of the causes of bitter complaint in Germany during the Great War having been the extensive use of the hated English weights and measures.

THE COMMON PROPERTY OF MANKIND

This survey of weights and measures throughout the world is necessarily brief. It is easy to say "English weights and measures are used in the United States," or "English weights and measures are used throughout the British Empire," but these few words state a condition that is decisive as to the question we are discussing. Seventy per cent. of the world's industrial energy before the war was exerted on the basis of English weights and measures. As one thinks of the world situation, the conviction becomes overwhelming that the English system no longer belongs to England and America, but that it is the common property of mankind, and that, if the world's weights and measures are ever to reach or move toward uniformity, it will have to be on the basis of the English system. That was plain before the war ended. The terms of the armistice make it "so evident it will glimmer through a blind man's eye."

HOW ENGLAND WOULD SETTLE THE QUESTION

This fact is recognized in the recent reports of four Parliamentary Committees appointed by the British Government in 1916 to study and

report on British policy after the war from which extracts are given in Chapter VI.

This recommendation of the Parliamentary Committees is in line with the fundamental principle of free government, which is to base legislation on the best practice by the people. Instead of issuing a compulsory edict that certain changes in weights and measures shall be made forthwith or that after a certain date the entire English system shall be abolished and another used exclusively, the British Committees take custom as their guide. They accept the English system as a permanent institution, like our language and law, which it is permitted to improve, but not to abolish, and then they refer the question of its improvement to the people, the actual users of weights and measures, in order that any changes may be real improvements based on experience. This is the essence of democracy.

A PLAN AS BROAD AS THE QUESTION ITSELF

It is no provincial spirit that this democratic plan is proposed by the British Parliamentary Committees. They recognize that it is a question in which the people, not only of the United Kindgom, but of all English speaking countries, have a common interest, and so they recommend that it be settled by the co-operation of the users of weights and measures in the British Empire and the United States.

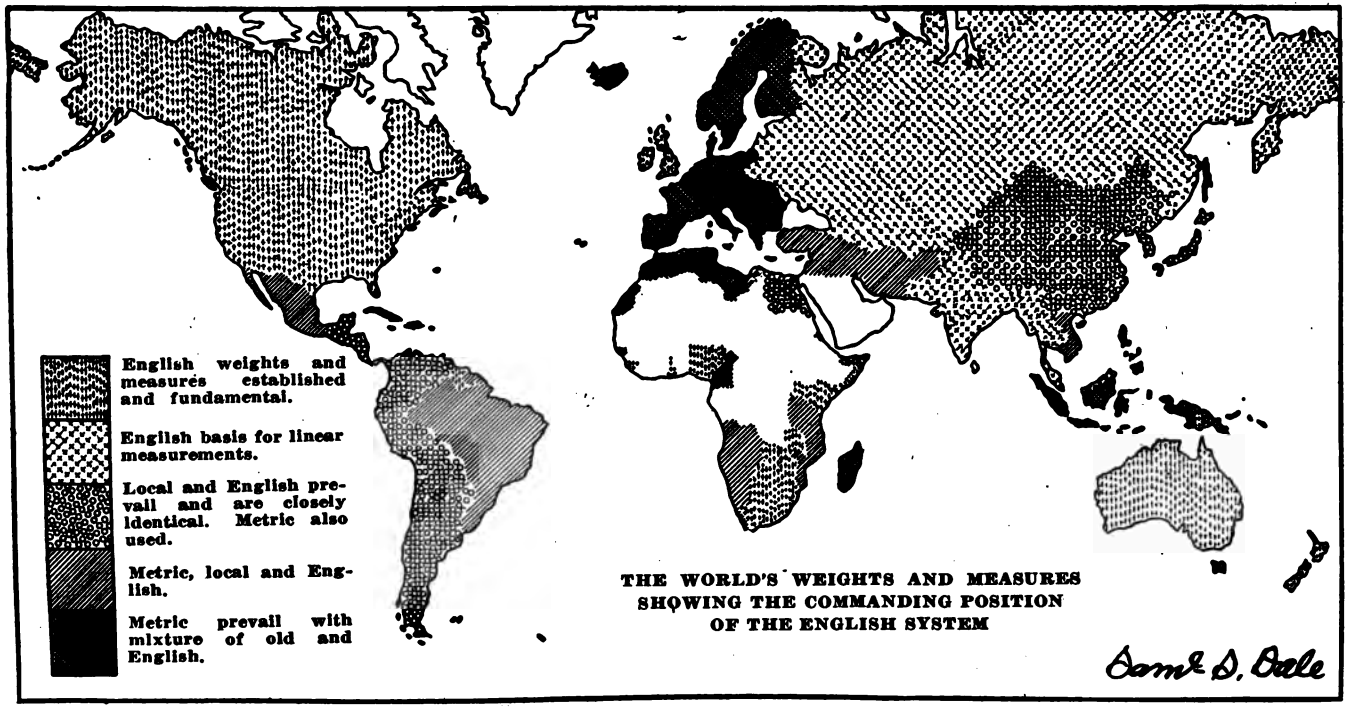
The recommendation of the British Committees is nominally addressed to Parliament and the British people, but in a wider sense it is an invitation to the British Colonies and Dominions and to the United States to join in the improvement and simplification of English weights and measures. The proposal should meet with prompt and enthusiastic approval in this country. No time should be lost in putting the plan into effect. This can be done by organizing an Anglo-American Conference on English Weights and Measures for the thorough study of the question in all of its bearings. It would be an excellent plan for two leading and representative engineering societies, one English and the other American, to take the preliminary steps in organizing the Conference, arranging for an investigation as broad as the question itself, which would mean its extension to every human activity and to every part of the English speaking world.[1] The representatives of every class of users of weights and measures should be invited to co-operate in this work. It is not merely a mechanical engineering question nor a textile problem. It relates closely, not only to engineering and textile manufacturing, but to all other industries, trades and occupations, and most important of all, to the daily affairs of all of the people.

[1] Since the above was written these preliminary steps have been taken as explained in Chapter XXV.

To be successful, such an inquiry must be kept free from irrelevant issues and confined strictly to the improvement and simplification of English weights and measures, as recommended by the British Parliamentary Committees. The British plan is based on the rejection of the metric system, and the metric controversy should be excluded from the inquiry.

The object of this inquiry is to correct certain defects in the English system, such for example as the use of the long ton of 2240 pounds, defects that are but a mote compared with fundamental imperfections of the metric system we are asked to adopt. Progressive legislation by the American Congress or the British Parliament is not an admission that free institutions are a failure. It is an effort to perfect the use of those institutions. Language study is not an admission that the English language is not the leading language of the world; it is an effort to improve the use of that tongue. And so the improvement of English weights and measures as suggested by the British Parliamentary Committees is not an admission that the English system is not the leading and the best system in the world; it is an effort to make it still better and simpler for the benefit of the unnumbered millions who are to use it in the centuries to come.

The suggestion as to the right way to handle this question comes to us from England, where the English system originated and has been maintained. It comes to us at a time when England and America, united by the war, now brought to a victorious conclusion, are facing the problems of world reconstruction. It is a plan based on reason and common sense and now is the appointed time to put it into effect.


English weights and measures established and fundamental.
English basis for linear measurements.
Local and English prevail and are closely identical. Metric also used.
Metric, local and English.
Metric prevail with mixture of old and English.
THE WORLD'S WEIGHTS AND MEASURES SHOWING THE COMMANDING POSITION OF THE ENGLISH SYSTEM
Sam'l S. Dale

Sam'l. S. Dale

THE WORLD'S WEIGHTS AND MEASURES, SHOWING THE COMMANDING POSITION OF THE ENGLISH SYSTEM.

This map summarizes the results of investigations that have been in progress nearly twenty years. These investigations are unique of their kind, and this map is the only comprehensive authentic exhibit of the weights and measures situation of the world as it exists today. It is an answer to the assertion that the metric system is in universal use except in the United States and Great Britain.

CHAPTER XIX

THE DECIMALIZATION OF WEIGHTS AND MEASURES

The term decimalization, as applied to weights and measures, has two meanings, which are often, in fact, usually, confused. The first meaning refers to the ratio between units and the second to the division of individual units.

The advantage claimed for the decimal ratio between units is that it facilitates transformation among them, or the operation of reduction ascending and descending, as the school arithmetics call it. In the United States, an extremely interesting process of unconscious evolution has been going on for many years by which we have substantially eliminated the process of reduction ascending and descending, and, in doing so, we have eliminated the supposed advantage of the decimal ratio. This evolution has been in the direction of the use of a single unit for any one purpose to the exclusion of its associates. Thus the pound has become the universal engineering unit, American engineers seldom using the ton, as English engineers still do. In the same way, the gallon is the unit for the capacity of reservoirs and municipal supply of water. The Engineers' surveying tape line and leveling staff contain the foot as the only unit, while longer distances on railroads, for example, are given in miles only. This process of evolution is nearly complete, except in machine shops where the foot and inch are still used in combination, although the tendency is against it, longer and longer distances being measured by the inch only, some shops having, in fact, entirely abolished the foot from their working drawings. Examples of the increased use of the inch for considerable distances are found in the practice with the diameter of locomotive driving wheels and the wheel base of automobiles, both of which are always given in inches.

This process sometimes results in the use of units which are apparently inappropriately small for some purposes, although this objection is chiefly imaginary. Thus, while the engineer uses the pound only for large quantities, he thinks in thousands of pounds which, while no name has been given to it, is really the unit of thought, and, again, in the matter of reservoirs and water supply the real unit of thought is a million gallons although it, again, has no specific name. In any event, the practice is far less subject to criticism than the universal machine shop use of the millimeter in metric countries. This practice makes calculations as

simple as in the metric system since we entirely avoid reduction between units and our calculations are strictly in accord with decimal arithmetic.

Moreover, this leaves us free to divide units as we wish, and, for purposes of measuring, they are commonly divided decimally, the foot of the surveyor's levelling staff and tape line being, for example, always divided into tenths, while fractions of miles are likewise expressed in tenths. On the other hand, for commercial purposes, binary divisions are universal. For example, the fractional weights of the grocer and druggist are always the half and quarter pound and ounce, while the yard, as used for the sale of dry goods, is similarly divided. For constructive purposes also the binary divisions hold, the inch in machine and carpenter shops being always thus divided. The fact is that, as a basis of constructive sizes, the decimal divisions are impracticable. The reason for this is a long one which we will not attempt to give here, but it explains the universal use of the millimeter in metric machine shops. They find it impracticable to use the centimeter as a unit and then divide it decimally, and resort to the millimeter which they multiply. The decimal dividing of the centimeter in metric machine shops is unknown and with it goes all claims for the merits of decimal division.

CHAPTER XX

SPECIMEN FLIGHTS OF THE METRIC IMAGINATION

"Careful estimates by experienced educators place the time saved by the adoption of the metric system from two-thirds to one year in the life of every school child." Dr. S. W. Stratton, Director of the Bureau of Standards.

"It puts a burden on our school children for it requires two or three years and even longer to learn the intricacies of the present system, while the decimal system can be mastered in thirty minutes." Dr. Harvey W. Wiley.

Chapter X shows that the time consumed in the study of denominate numbers and weights and measures in the schools of the City of New York aggregates between 2.2 and 3.3 weeks according to the aptitude of the pupil. If the old units are to continue in use here, as they have in every so-called metric country, the children will have more and not less to learn.

"The metric system is universal in chemistry." General Chorus.

The replies to the questionnaire which is the subject of Chapter III include nineteen from chemical manufacturers (page 43), not one of whom makes any use of the system whatever.

"The metric units are universal in the electrical industry." G. E. M. Thompson and many others.

Metric units are not used in the construction of electrical machinery, the foot and inch being as universal there as in the lumber industry.

"When the same signs and symbols express to all the same weights and measurements this will mean a distinct advance along the road to international peace." Dr. Geo. F. Kunz, President the American Metric Association.

Since 1870 "the same signs and symbols" have expressed the same weights and measurements in France and Germany but, according to common report, those countries were recently at war. Since the landing of the Pilgrim Fathers "the same signs and symbols" have expressed the same weights and measurements in the United States and Great Britain but, if history is true, those countries have been at war twice.

"In spite of positive assertions from certain antimetric quarters that it would be dangerous to change our measures during the war, the General Staff found that on the spot practical conditions made the adoption of the metric system the only rational step." Mr. Fred R. Drake, Chairman Executive Committee the American Metric Association.

The war maps of France are metric and to secure agreement it was necessary that the gun sights of our military arms be graduated accordingly. The difficulties involved in this use of the system were at a minimum because the yard and meter do not greatly differ. There was no trace of the metric system in the construction of our military or naval equipment. It was found necessary to translate the dimensions of the 75 and 155 mm. field pieces, of which the designs were taken over from France, and of the Caproni air plane, which came from Italy, into English figures before the work was done.

This quotation is typical. A relatively simple and very partial change to the metric system is represented to be its adoption, the reader being left to infer that by adoption is meant universal use. Metric literature is saturated with this misrepresentation. Metricites seem incapable of learning that while some changes are easy others are impossible.

"Dr. Geo. F. Kunz . . . has asked Secretary Baker to take a timely step in the direction of reform. He has invited the head of the War Department to have the new guns and other weapons of war made in accordance with the metric system." New York Evening Mail, Apr. 14, 1917.

The carrying out of this suggestion would have involved the following:

1. The remaking of many thousands of drawings.
2. Equipping the shops with thousands of metric precision measuring instruments and gages of which, at the time, there were not sufficient in the country to supply a single shop.
3. The remaking of thousands of special tools and fixtures at a time when labor for this class of work (tool makers) was almost unobtainable.
4. Supplying metric screw threading tools and apparatus and providing screw threading machines, including lathes, with metric lead screws and change gears. Of these, again the country did not contain enough to equip a single shop.
5. Teaching every mechanic engaged in the work the use of the system. The magnitude of this undertaking may be learned from Chapter XI, Learning the Metric System.

It is a safe assertion that had the suggestion been adopted we would not have gotten into the war at all and that if, as some believe, our assistance was essential, Germany would have been the victor.

The explanation of this suggestion is that its author is *an expert in precious stones* who has no knowledge of machine shop work.

"Calculations in the metric system are two or three times as accurate as in the English system." Dr. Jos. V. Collins.

The accuracy of calculations has no relation to the system of measurements used.

"As the minority has agreed beforehand that it will accept the will of the majority and abide by it, at least until, through proper constitutional and lawful methods the

expression of that will may be changed, there is, in a lawful sense, no exercise of compulsion by the majority as against the minority. Having willed in advance to accept the decision, we should not be acting against our will under the decision, and therefore, would not be subject to compulsion but rather to enlightened and frankly invited coöperation. We consider the term "Compulsory law" a contradiction of democracy, a term that should not be applied to any statute duly adopted by the National Congress and adjudged to be constitutional by such machinery as the democracy has set up." The Valve World, May, 1919.

German logic outdone.

"It is the sole system in all Latin-America." Mr. Judson C. Welliver.

"In Central and South America the metric system is practically universal." Collier's Weekly.

"It is practically universal throughout Central and South America." Mr. Everett Morss.

"It is the system used in every day life by the civilized peoples all over the world, except in America, Great Britain, and her colonies." Dr. A. E. Kennelly, Prof. Electrical Engineering, Harvard University.

"Scarcely a vestige of the old standards is left in any country that has adopted the metric system." Dr. Wm. C. Wells, Chief Statistician, The Pan American Union.

"The theory that old units will always live is repudiated by experience in some thirty-odd countries which have successfully adopted the metric system of weights and measures." Mr. Howard Richards, Secretary, American Metric Association.

"America and Brittania are the only civilized nations that have not yet adopted these standards," World Trade Club.

Consult Chapters I and II.

"In less than a year one would have forgotten that there ever was any other system." Mr. Adolph W. Miller.

"To adopt the metric system would not be harder for the United States than to adopt the daylight saving plan." Mr. Arthur Brisbane, Editor the Hearst papers.

Consult the experience of other nations Chapters I and II.

"The meter, liter and gram continue to prove most satisfactory in official and general use in Philippine Islands, Porto Rico and other United States possessions." Mr. Fred R. Drake, Chairman Executive Committee American Metric Association.

Consult Porto Rico page 27 noting especially the observations of Mr. Holbrook of the Bureau of Standards.

"It is a matter of little interest that on the manifest of the ship that brought these goods [wheat, cotton, oil, iron, copper and the like] they were denoted by these [English] measures. Not so if the goods be shoes, cloth, screws, clothing, *tools* and *machinery*. Here the inch, the yard and the pound are wrought into the article as a part of its warp and weft. He cannot sell them. His customers will not buy them. The man who needs a bolt or nut threaded to the metric scale will not take such as are threaded to the inch scale. Nothing fits, nothing suits and, finally, nothing is sellable." Dr. W. C. Wells, Chief Statistician the Pan American Union in the *Bulletin* of the Pan American Union, January, 1917.

The above was written before its author had seen the Report on the Metric System in Latin America which forms the subject matter of Chap-

ter II. After that report had been sent to him he gave an interview to the New York Herald from which the following is a quotation. Note the italicised words and compare the reference to cloth with the finding of Mr. W. A. Graham Clark, Commercial agent of the Department of Commerce, that cloths are seldom sold in Latin America by the meter and the reference to clothing with the large use of the inch for this purpose throughout Latin America as shown in Chapter II and read the following later views of Doctor Wells:

"It would be unfortunate if the answer to this question be involved with the question whether or not American industry should or should not change from the English to the metric system.

"Everyone recognizes that there is a connection in the matter of measure between our domestic manufacturer and the export trade, more or less direct, but it is much less direct than is ordinarily believed. Sometimes the measure counts, sometimes it does not. The list where measure does not count or scarcely ever acts as a handicap is broader than potatoes, apples, or coal oil. Such examples are *padlocks, watches, clocks, sewing machines, typewriters, cash registers,* and the like." Dr. W. C. Wells, chief Statistician the Pan American Union in the New York Herald for Apr. 6, 1919.

It is quite clear that, between these expressions of opinion, the education of Doctor Wells made rapid progress. When he learns that to his list of mechanical products there should be added, with insignificant exceptions, all manufactured goods of whatever kind and for whatever purpose, he will, perforce, give up his advocacy of the system for the benefit of export trade.

"The average child of 10 who knows the metric decimal dollar and its subdivisions can learn in 10 minutes as much of the metric system as 90 per cent. of all the people ever have occasion to use." The World Trade Club.

Consult Chapter XI Learning the Metric System.

"Panama, Philippines, Porto Rico, Cuba—parts of U. S. America—have long used meter-liter-gram." The World Trade Club.

Consult Panama page 25, Porto Rico page 27, Cuba page 19.

"Strange as it may seem, the present coinage of the British Isles as well as the weights and measures of the British Isles and of America are German." The World Trade Club.

As well claim that Germany invented the English language.

"The German Kaiser would not have dared to declare war if America and Britannia had been standardized on metrics when the Germans adopted the system exclusively in 1871." The World Trade Club.

Germany did not declare war on the United States or Great Britain the declarations in both cases having been the other way about nor did she in the beginning expect either country to come in. Germany did declare war on France, Belgium, Italy, Russia, Serbia and Roumania,

all of which countries, according to metric belief and representations, are metric.

"The large French population of Canada has greatly increased the use of the metric system there." The World Trade Club.

Mr. E. O. Way, Chief Inspector of Weights and Measures for the Dominion of Canada, writes:

"The use of metric weights and measures in Canada is practically nil and less in our Quebec Province than any other."

"The Allies gained victory in the World War by all standardizing with metric units." The World Trade Club.

They did nothing of the kind.

"The United States Government are using the Metric System almost exclusively in the manufacture of aeroplanes." Metric News.

Except for the screw thread of the spark plugs there was no trace of the Metric System in American aeroplane war work Even the Caproni plane, of which the design came from Italy, had its dimensions translated from Metric to English figures.

The World Trade Club publishes a map of the world which purports to set forth the present weights and measures condition of the world. In this map Greenland, Patagonia and the Sahara Desert are set down as metric. Comment is unnecessary.

CHAPTER XXI

THE STORY OF THE BERRY BASKETS

This story illustrates the zeal with which the Bureau of Standards seizes every opportunity to foist the metric system on the people of this country and the devious methods to which it is prepared to resort in order to accomplish the purpose. In 1911 there was a great deal of variation in the sizes of berry baskets throughout the United States. Some of the States had laws making the dry quart the legal measure for berries and small fruits, the offering of such commodities in baskets of other capacity being illegal, and those so offering them subject to a fine. Some of the Southern states had no such laws, and early strawberries were hence shipped to Northern markets in baskets of smaller capacity, which baskets, while legal at the point of shipment, were illegal at the point of consumption. To remedy this anomalous and troublesome situation, a committee of produce dealers endeavored to obtain the passage of a law at Washington making the dry quart the only unit of measure for small fruits and berries throughout the country. Upon applying to the authorities at Washington they were referred to the Bureau of Standards, whose officials framed for them a bill which was subsequently introduced in both the House and Senate. This bill provided that the dry quart should be the standard for berry baskets, but also contained this proviso:

"Provided that nothing in this act shall prevent the sale of such small fruits and berries by weight or by the liter, half liter, quarter liter, or multiples of the liter."

Now the liter is about ten per cent. smaller than the dry quart, and to everyone familiar with that fact it becomes evident at once that the metric proviso would nullify the main object of the bill and actually make the liter the United States standard for berry baskets, for no dealer could afford to sell by a large quart while his competitors were selling by a small one. The small liter would surely drive the large quart out of use. Fortunately when this bill was introduced the metric joker was discovered by Mr. Dale, who sent a protest against it to both the House and Senate Committees to which the bill had been referred. He also started an investigation and discovered that the fruit and produce dealers who had promoted the movement to secure a uniform standard based on the dry quart, had been informed by the representative of the Bureau of Standards that the officials of that Bureau would not care to frame a bill that

would in any way interfere with the metric system. Becuase of the official prestige of the Bureau, the deference paid to it by members of both House and Senate and the failure of the produce men to recognize the effect of the joker, this decision settled the matter. Accordingly the bill was framed with the metric joker of the Bureau of Standards in it.

After the exposure of the effect of the metric joker, a representative of the Bureau of Standards at a subsequent hearing before the House Committee on Coinage, Weights and Measures, when questioned on the subject, said the Bureau would not insist on the metric proviso, and when the bill fixing the dry quart as the standard for berry baskets became a law on August 31, 1916, it contained no metric proviso. If the policy of the Bureau of Standards had prevailed both the metric liter of sixty-one cubic inches and the dry quart of sixty-seven cubic inches would have been legal standards for berry baskets, causing confusion worse confounded and constant loss to millions of consumers throughout the country. And all for what? Why, that the Bureau of Standards might prevent anything from interfering with the metric system.

When during the berry season we see the berries and small fruits in the market and delivered to our homes packed in baskets of uniform size, each holding a dry quart or a binary division of a dry quart, it will be well for us to remember that confusion and fraud were prevented and this uniformity was brought about because the plan of the Bureau of Standards to force the liter on the country was thwarted in 1911 by a timely exposure. The officials of that Bureau have shown themselves willing to legalize the confusion of a double standard if they can accomplish their object, which, first, last and all the time, is to get the metric system in.

CHAPTER XXII

THE "METRIC" CARAT

One of the recent claims for the advance of the metric system is the introduction by Dr. Geo. F. Kunz, President of the American Metric Association, of a new carat for weighing gem stones which is claimed to be metric because its value is 200 milligrams.

When introducing this unit Doctor Kunz did two things:

First, he brought order out of chaos by establishing one value to the carat where it formerly had twenty or thirty.

Second, having done this by defining the new carat in metric terms, he proclaimed the result as due to the merits of the metric system.

The results of his work are due to the fact that we now have one carat where we formerly had many. The new carat could just as readily have been defined in grains as in milligrams, and, had that been done, the same uniformity would have followed. Assume for the moment that it had been done, and the result claimed to be an illustration of the superiority of the English system. Would not this claim have been, on its face, absurd, and is not the claim that the result is due to the merits of the metric system just as absurd? It is to all except metric devotees.

When it is done, the new carat is a special unit for weighing precious stones and, as such, is on all fours with the Troy ounce, which is a special unit for weighing precious metals. The metric party now glorify the carat because they call it metric, and vilify the Troy ounce because it is called English. As a simple matter of fact, if one of these units is good, the other is good; if one is bad, the other is bad. Which is it? Are both good, or both bad?

When standardizing the carat at 200 milligrams, Doctor Kunz innocently confessed the inadequacy of the decimal ratio ($200 = 10 \times 10 \times 2$), the unsuitability of the old metric units for special uses, and the need of others. The metric party is fond of saying that anything can be weighed or measured in one system of units as easily as in another. Why, then, are not gem stones weighed in milligrams or centigrams? Why was it necessary to originate a new unit for that purpose? This unit is a confession by the metric party that the milligram is not suited to their use, and it is now for them to cease denouncing those who find the millimeter unsuited to theirs.

Doctor Kunz's claim that the new carat is a metric unit because it

has been standardized in metric terms does not stand alone. Dr. William C. Wells, Chief Statistician of the Pan-American Union, claims the French aune as a metric unit because it has been standardized at 120 centimeters, and that the French denier has, in the same way, become a metric unit because it has been standardized at 150 or 155 milligrams (he is not sure which), the former ratio containing the factors 5 and 3 and the latter 5 and 31. There is also the French pound of which two equal a kilogram and which is always claimed by the metric party as a metric unit. Likewise, there are others, for example, the French inch of which thirty-seven make a meter, and the South American gallon which is equal to four liters. If these units are metric, as is claimed for most of them—and the claim is just as good for one as for another—then we have as parts of the metric system the ratios 12, 5, 3 (or 31), 2, 2 again, 37 and 4.

Plainly, this will not do. The chief point on which the English system is regularly denounced by the metric party is its miscellaneous ratios, while the chief claim for the metric system is its use of the single ratio 10. If the metric system is a decimal system, none of these units, including Dr. Kunz's carat, is metric, while if it, and with it the others, are metric, the metric system does not differ from the English as regards miscellaneous ratios. The metricites cannot claim both sides of the argument. They must give up calling a unit metric because it has been standardized in metric terms, or they must admit that the metric, like the English, system is characterized by miscellaneous ratios.

(The virtues of his carat and its metric origin formed the subject of an article by Doctor Kunz published in the *Scientific American*. This chapter was originally prepared as an answer to that article, but the *Scientific American*, which is ardently pro-metric, refused to print it.)

CHAPTER XXIII

THE WORLD TRADE CLUB[1]

For the past six months, beginning with March, 1919, a mysterious propaganda has been carried on by mail throughout the United States and Great Britain under the name of "The World Trade Club," with headquarters at San Francisco, from which city vast quantities of expensive literature have been mailed broadcast, appealing to all classes of people in all parts of the United States, Canada and Great Britain for support of a movement to secure legislation by the United States Congress and the British Parliament making the use of metric weights and measures compulsory and prohibiting the use of the English weights and measures now established.

A MYSTERIOUS ORGANIZATION

The mystery surrounding this World Trade Club of San Francisco was due to its sudden appearance, no one ever having heard of it before, the vast extent of its mail campaign, whether measured by the number of expensive circulars sent out or the great extent of territory covered, the lavish expenditure of money in the work, and the deliberate omission of the name of its principal, if not its only, financial backer from the literature distributed by the Club.

The arguments advanced in this San Francisco literature deserved no consideration in any serious discussion of weights and measures, but were framed to appeal to the large number who habitually confuse the metric system with decimals, and currency with weights and measures, and to stir up a senseless clamor instead of leading men's minds to the truth. So instead of attempting the impossible task of drowning it with a counter clamor I have directed my energies to finding out what was back of this mysterious propaganda. During the six months that it has been under way I have been patiently collecting the evidence and now the occasion seems opportune to make public what I have discovered.

In reporting my findings I shall not refer by name to one important individual connected with the World Trade Club, but shall designate him as "Mr. Z.," leaving it to Mr. Z., if so disposed, to make known his identity and give to the public the information that I have not yet secured. Various sources of my information will also be designated by numbers as I have not asked permission to make public the names of my informants.

[1] By Mr. Samuel S. Dale.

CHRONOLOGY OF THE PROPAGANDA

March 29. The World Trade Club's mail campaign begins with an expensive circular printed in colors, accompanied by a circular letter bearing the printed signature "Wm. E. Hague, Secretary-Treasurer," asking that the recipients sign the petitions enclosed and addressed to President Wilson, the House Committee on Coinage Weights and Measures, British Prime Minister Lloyd-George and the British Parliament, endorsing the exclusive use of the metric system "by legislation, promulgation or order in council" in the United States and British Isles, two stamped envelopes addressed to the President and Prime Minister being also enclosed for mailing the petitions.

Attached to the circular was a slip on which was printed this request:

"This is a copy sent to you in advance of printing a very large edition. Can you improve, strengthen, condense, correct or contribute one more fact? Do it for the benefit of all human kind. Do it quickly, *for the press is started. Telegraph Collect,* Ramsey Mailing Co., 618 Mission St., San Francisco, World Trade Club."

March to September. Four different editions of the World Trade Club circulars, revised and printed in more expensive form, are spread broadcast throughout the United States, Canada and Great Britain, being mailed, not only to newspapers and organizations, but to individuals in all walks of life, and in every case enclosed with stamped envelopes addressed to President Wilson and Prime Minister Lloyd-George.

July. An entirely new circular distributed by the World Trade Club, having attached to it a resolution "*voted unanimously by the World Trade Club on June* 18, 1919," urging that the United States Congress and the British Parliament adopted the metric system as the exclusive, legal standard.

March to September. Many newspapers and periodicals publish pro-metric articles and editorials based on the World Trade Club circulars, in some cases naming the World Trade Club and in others letting the articles appear as if they were original. Among the publications that "fell" for the San Francisco stuff was "Commerce Reports," issued by the Department of Commerce, which includes the Bureau of Standards, and which published the pro-metric resolution "passed unanimously" by the World Trade Club.

REPORTS OF INVESTIGATORS

May 12. A letter from the World Trade Club to New England correspondent No. 1 states:

"This movement is world wide and there are headquarters for furthering the project in New York, Brussels, Sydney, Tokio, Rome and other large cities of the world."

May 20. San Francisco correspondent No. 2 investigates the World Trade Club and writes:

"The World Trade Club is located in an office on Mission Street without any indication of its presence on the entrance door or elsewhere. A man connected with an advertising agency located there stated the funds for the work came from various societies throughout the world."

May 24. San Francisco correspondent No. 3 investigates and reports:

"Wm. E. Hague, secretary of the World Trade Club, who is also secretary of the One Hundred Per Cent. Club and the Foreign Trade Club, states that the work of the World Trade Club is being financed by Mr. Z., a wealthy business man of Boston now residing at the ——— Hotel in this city. Mr. Z. is actuated solely by a desire to benefit the human race by bringing about the adoption of the metric system. It is his hobby and he has the money to gratify it."

May 28. San Francisco correspondent No. 4 investigates and reports:

All this circularizing is financed by a rather mysterious individual named Z. He has paid about $80,000 to one local advertising firm and the total cost to date is around $100,000. No one at the address of the World Trade Club wanted to say anything. There are two theories about Mr. Z.'s purpose. He may be trying to improve the Allies' foreign trade balance by securing international adoption of the metric system, or he may be carrying out the hobby of a rich eccentric."

June 9. San Francisco correspondent No. 3 investigates and reports:

"The statement that Mr. Z. is a wealthy Boston business man is misleading, as we find that he was formerly engaged in manufacturing somewhere in Massachusetts. He is credited with being a millionaire, but however this may be, he is spending a lot of money in the prosecution of his hobby, pays his bills and asks no favors or contributions to promote the work. The above information was obtained from Mr. Hague, whom I have known well for many years and in whom I have the greatest confidence."

June 23. San Francisco correspondent No. 5 investigates and reports:

"Mr. Z. seems to have unlimited funds and pays promptly. He invariably desires to know the exact amount to be paid several days before the account is due."

June 23. San Francisco correspondent No. 2 investigates and reports:

"Mr. Z. has engaged the services of the Ramsey Mailing Co. to print, mail and distribute a vast number of circulars and this work is being paid for by Mr. Z. *The name 'World Trade Club' is adopted simply for convenience and to give more weight to the matter sent out than if it was signed by an individual. Mr. Z. is doing this work quietly and has made no effort to gain the personal publicity which might easily have been his.*"

July 14. San Francisco correspondent No. 3 investigates and reports:

"I have interviewed Mr. Z., who was the subject of our recent correspondence. Mr. Z. is devoting a large part of his private fortune in presenting to the public arguments for the exclusive use of the metric units. Literature is being sent out under the name of the World Trade Club *as a matter of convenience and to avoid the appearance of being the work of an individual, which, in Mr. Z.'s opinion, would detract from its effect.*"

FAKE "NEWS ITEMS"

Aug. 11. The World Trade Club introduces a new feature into its propaganda by sending to the press "News Items" printed in typewriter type with this "Note to the Editor:" "Release immediately. Please insert current date." These "news items," which bear the name "W. H. Hammer, President," in addition to those of the Club and Wm. E. Hague, all relate to the pro-metric propaganda. Their value as "news items" can be judged from two of them.

One of these quotes as if it were recent a pro-metric statement by Secretary of Commerce Redfield, which I find was made by that official in a speech in Baltimore on Dec. 27, 1918, eight months previous to its appearance as a World Trade Club "news item."

In this San Francisco Club the flight of time does not affect the news value of the items in which the newspapers of the country are asked to "insert current date" and "release immediately."

For example, one of these items quotes without naming the date a pro-metric statement by Andrew Carnegie, which on investigation I find was made by Carnegie in a letter dated Cannes, France, Dec. 13, 1897, and addressed to Albert Herbert, Boston, Mass., twenty-two years preceding the date on which the editors of American newspapers are asked by the World Trade Club to "release it immediately" as a "news item," inserting "current date."

"A THOUSAND DOLLARS FOR ONE WORD"

August 11. The World Trade Club sends to the newspapers a release-immediately-please-insert-current-date "news-item," making this announcement:

$1000 Will Be Paid for a Single Word

"San Francisco, August ——. Can you create the one word which will best denote the United States and all parts of Britain? If so, you will be paid at the rate of $1000 a word. The World Trade Club of San Francisco has offered $1000 to the person who suggests the word which, in the judgment of the Club's Metric Campaign Committee, is best adapted to world-wide use. The World Trade Club is offering this award because in carrying on its present campaign for the adoption of metric units by all English-speaking people, it was hampered by the lack of a single short word which would express all English-speaking countries. The money will be paid to the winner at noon on May 15, 1920."

FAKE EDITORIALS TO INFLUENCE CONGRESS

August 11. The World Trade Club seeks to relieve the editors of newspapers by sending them "suggested editorials on metric weights and measures." Here is the title with a few significant passages from one of these ready-made "editorials," which the editors were to use as their own in order to persuade people in all parts of the country to write to

their Representatives and Senators, urging legislation to make the metric system compulsory and the English system illegal:

"TELL YOUR LEGISLATORS

"For months past the World Trade Club of San Francisco and the Metric Association of New York have been waging a vigorous campaign for the adoption of the metric units of weight and measure by the United States.

"World Trade Club particularly has been right on the job. The copious literature issued by the club has shown with relentless logic the need for world-standardization of weights and measures, and the great gain the metric system would bring to the United States in trade, in manufacture, in education.

"Hundreds of America's most eminent men have taken the trouble to write or telegraph World Trade Club pledging support to the campaign.

"All this is very well.

"Reasons are good; but acts are better.

"World Trade Club is doing its part. But there is still an important step to take.

"It is: *to get the thing done.*

"In other words, the matter is now up to the *legislators* of the United States, particularly the *members of Congress.*

"Congress has dallied with this subject ever since the days of Thomas Jefferson.

"Our legislators lacked the 'gumption' to adopt meter-liter-gram. In 1866 Congress made the metric system legal. Why was it not made exclusive? Now is the time to remedy the error.

"Our legislators know this. They know, too, that metric standardization will remove a great handicap on commerce and education. But they need to be reminded —to be written to—to be urged to get the thing done.

"Write today. A postal will do it. *Write your Senators, your Congressman. Get the thing done. Tell your legislators.*"

August 16. Announcement by press dispatch from Washington that, because of a great popular demand, a bill making the metric system compulsory is to be introduced in the House of Representatives by Congressman A. H. Vestal, Chairman of the Committee on Coinage, Weights and Measures, and that extended bearings will be given on the measure.

LENDING WEIGHT TO THE PROPAGANDA

Sept. 10. San Francisco correspondent No. 3 investigates and reports:

"The World Trade Club is not in any sense an organization such as the name implies, *it being merely a name adopted for the purpose of lending weight to the propaganda* such as it would not carry over the name of an individual. It is of course impossible for this to become generally known, but as the local sponsors of the movement are within their rights in making use of this title, I see no way in which it can be prevented."

EFFECT OF THE CLAMOR

Sept. 15. I call on Chairman Vestal of the Committee on Coinage, Weights and Measures, and he tells me the report of Aug. 16 is correct,

that a metric bill is to be introduced in the House, the reason being the great clamor for such a bill, thousands of letters having come from all parts of the country. I ask him if he knows what is back of this clamor. "Yes," he replies. "World Trade Club?" I ask. "Yes," is his answer. "Do you know what the World Trade Club is?" I ask. "No," he replies, "but I propose to find out before I get through with it."

SUMMARY OF THE CASE

The information given above regarding the World Trade Club of San Francisco, obtained from a number of independent sources, is all in agreement and indicates that this Club is backed financially by one man, Mr. Z, whose name does not appear on any of the vast quantity of literature which has been mailed under the name of the World Trade Club; that of the two names, W. H. Hammer and Wm. E. Hague, appearing on this literature, the former is not mentioned in any of the various reports, while the latter is referred to in complimentary terms in one of the reports, and appears to be acting as a secretary of several San Francisco organizations, including the World Trade Club, in which he is evidently not the moving spirit; that the World Trade Club has expended a very large amount of money in an extraordinary extensive mail campaign with the object of manufacturing directly and through the press a public sentiment that would lead a sufficient number of people in all walks of life and all parts of the country to bring pressure to bear on the members of both branches of Congress at Washington and of the Parliament at London to enact legislation making the use of the metric system compulsory and that of the English system illegal; that the principal and apparently the sole financial supporter of this World Trade Club is the mysterious Mr. Z, who is reported as being actuated by a desire to benefit the human race, and who withholds his own name and conducts the propaganda under the name of the World Trade Club because it would carry more weight under that name than under the name of an individual.

It also appears that up to the present time Mr. Z's plan has attained a certain success in the United States. The effect of the propaganda has been such that, as Chairman Vestal admitted, enough people have written to their Representatives in Congress to create a pressure which is leading to the introduction of a compulsory metric bill and to the granting of hearings on it before the House Committee on Coinage, Weights and Measures.

TURN ON THE LIGHT

For one I wish to enter my protest against this method of manufacturing and misleading public opinion. Before this propaganda to

force the metric system on the American people and make it a crime punishable by fine and imprisonment to use our English weights and measures goes any farther, I ask the Committee on Coinage, Weights and Measures to call upon Mr. Z of the World Trade Club to disclose his identity and give all the facts regarding the mysterious and objectionable propaganda he has been carrying on from San Francisco for the past six months, in order that the people and their Representatives, not only in the United States, but in all English-speaking countries, may know what the World Trade Club actually is and who is or are back of it.

It may be that this San Francisco campaign is the work of only one man, who is devoting his private fortune to the propaganda in the sincere belief that it is all for the benefit of mankind. If so, the American people and their Representatives at Washington should know it, so as to be able to place the proper weight on the pro-metric influences radiating from San Francisco for the past six months.

On the other hand the mystery surrounding this World Trade Club, its lavish expenditure of money (reported at $80,000 for one edition of its circulars, of which there already have been four) and its methods of agitation are such as to excite the suspicion that it is not the enterprise of one man, but is a deep-laid scheme by a group to accomplish in 1919, when world affairs are in a state of flux, something that has heretofore been impossible, the compulsory introduction of a foreign system of weights and and measures in English-speaking countries. If that is true, then the English-speaking peoples and their Representatives should know it.

Whichever of these two theories may be the truth, one thing is certain. No individual or group should be allowed to carry on a propaganda under cover of a misleading name, such as "World Trade Club," for the purpose of exciting popular clamor and by that means securing the enactment of special legislation by Congress or the Parliaments of other countries.

END THE ARTIFICIAL PRESSURE ON CONGRESS

The regulation of weights and measures is one of the most difficult problems of government. A mistake in the control of fundamental standards is almost certain to prove irreparable. Any proposal, therefore, to change an established system calls for a thorough knowledge of the facts, clear thinking, calm deliberation and complete freedom from the influences born of bias developed by propaganda.

Let there be an end once and for all to the artificial pressure that has been brought to bear on Congress to enact compulsory metric legislation, a pressure that for nearly twenty years has had its source in the Bureau of Standards and which for six months has been intensified by the mail campaign of the mysterious World Trade Club of San Francisco.

CHAPTER XXIV

THE METRIC SYSTEM AND THE VALVE WORLD[1]

The Crane Co., Chicago, Ill., is the leading advocate of the metric system in this country. It conducts a constant agitation for that system in its house organ, The Valve World, which is edited by Justin W. McEachren. There can be no doubt as to the responsibility for the agitation. Mr. McEachren has not only defined the position of the Crane Co., but has given a very explicit account of how the managers of the company decided on a course of action to promote the metric system. In an address before the American Metric Association at Pittsburgh, Mr. McEachren said:

"The Crane Co. deliberately reached the conclusion that it would ally itself with the advocates of the widest practical adoption and use of the metric system.

"We resolved ourselves into a Committee of the Whole, with Common Sense in the chair.

"We satisfied ourselves that we were equipped to study the question of international industry and standards with an international mind. This was the hardest matter we had to decide. The rest was comparatively easy.

"So we speedily reached the conclusion that we understood the meaning of international standards to be the standardization of sizes.

"We decided straightway to join the pro-metric forces and to wield such influence as we might in preparing for the fullest and widest practical use of that system. With this decision the matter was turned over to the Editor of The Valve World, and in its pages for the last six years you may read how he has carried out his instructions."

CARRYING OUT HIS INSTRUCTIONS

Mr. McEachren tells us that by turning to the pages of his organ we can see how he has carried out his instructions. First let us read his profession of faith:

"Advocates of the more general use of the metric system ask only the freest and widest discussion of the question in all its bearings. They make no restrictions. The metric system advances because it is scientific

[1] By Mr. Samuel S. Dale.

and because it is unafraid. It courts the widest and most unlimited discussion."

Those are brave words, but a diligent search of the weights and measures discussion during the past hundred and thirty years reveals no metric advocate who has lived up to them. They may ask for free discussion, but they invariably refuse to accept it. Their case is based on the assumption that the metric system is in wide use, that it makes its way on its merits, and that it is intrinsically a superior system well adapted to the work of the world. They refuse to face the facts, because to do so would show that their claims as to the extensive use of the metric system are to a great extent false, that the system has made its way only by compulsory laws backed by penalties of fine and imprisonment for their violation, and that intrinsically it is defective and unsuited to the needs of man. As the metricites cannot face the facts the only course left is to run away from them or to distort them in some closed forum where exposure of the misrepresentation is forbidden; for example, before the National Wholesale Grocers' Association[1] or in the organ of the Crane Co.

If there is anyone who thinks this indictment is too severe he can find complete confirmation of it in the pages of the Crane Co.'s organ, to which Mr. McEachren invites attention. There he will find a wide divergence between profession and practice. A few typical examples:

SUPPRESSING THE BRITISH REPORTS

An example of the suppression of facts damaging to the metric cause by the organ of the Crane Co. is found in connection with the report of the four Parliamentary Committees on British Industrial and Commercial Policy after the War, from which extracts will be found in Chapter VI, which were appointed by the Asquith Government in 1916. These four Committees, after a thorough investigation lasting eighteen months, rejected the proposal to introduce the metric system into the United Kingdom. Their reports, made public early in 1918, were of the first importance, but anyone who relied on the organ of the Crane Co. for information would have remained in ignorance of their existence to this day. There was no excuse for this suppression. The reports were widely published and Mr. McEachren was asked in July, 1918, to print an abstract of their anti-metric decisions.

His was an embarrassing position. He had his instructions to carry on a metric propaganda. His way of carrying out his instructions was

[1] A request for an opportunity to read a paper before this Association was refused by its secretary under date of March 31, 1919, in these words: "We could not think therefore of allowing you a place on that program or in any of our proceedings to present your case when it is diametrically opposed to the views we hold. The above is also the expression of our Metric System Committee of which Mr. Fred R. Drake of Easton, Pa., is chairman.

to suppress the reports. And yet this representative of the Crane Co. declares in public that he "courts the widest and most unlimited discussion."

FOREIGN TRADE AND LATIN AMERICA

The American Institute of Weights and Measures has published reports of two investigations. The first, in 1917, was an exhaustive inquiry into the use of the metric system in export trade[1] and showed that the claims made for the metric system in export trade are unfounded. The second investigation related to the weights and measures of Latin America[2] and showed that the introduction of the metric system has resulted only in confusion, because of the mixture of the metric units with the Spanish and English systems, also that the Spanish and English systems are so closely identical as to make it comparatively easy to unify the weights and measures of the Western Hemisphere on the English basis. Here again were facts constituting new and conclusive evidence of the hollowness of the metric claims in general and of the Crane Co.'s formula in particular. Another embarrassing situation. How did Mr. McEachren carry out his instructions? Again by suppression.

FUNDAMENTAL STANDARDS

In the February, 1919, issue of the Crane Co.'s organ there is a comment, divided into seven numbered sections, on a circular letter signed by Geo. S. Boudinot, secretary of the National Association of Manufacturers, which gave the text of anti-metric resolutions adopted by that organization. In that comment Mr. McEachren said:

"2. The international prototype meter and kilogram are regarded by statute as 'fundamental standards.'

"3. All the important nations of the world have received and used accurate copies of the metric standards, and these are the only 'fundamental standards,' with every important nation except Great Britain."

Both statements are wrong. No United States law has ever recognized the meter and kilogram as fundamental. The law of 1866 making the use of the metric system permissive specifically recognized the English system as fundamental by defining the metric units in terms of the English system. A meter was defined as 39.37 inches; a kilogram, as 2.2046 pounds, etc. Many have been misled into believing the contrary because a superintendent of the Bureau of Weights and Measures at Washington issued an order in 1893 that the yard should be derived from the meter by comparison with the lines on a metric bar that had recently been received from Sevres. That was a mere detail in the work

[1] This investigation forms the subject of Chapter III.

[2] This investigation forms the subject of Chapter II.

of a national sealer of weights and measures. It had no more effect on our fundamental standards than a like ruling by a sealer of weights and measures in the city of Chicago would have, because the Constitution gives to Congress the sole power to fix the standard of weights and measures. The English system is the United States standard by both common and statute law. The contrary belief has been encouraged by the officials of the Bureau of Standards, who have included this 1893 ruling of a bureau in a compilation of "Laws of the United States on Weights and Measures." But that proves nothing except that pro-metric bias is not confined to the organ of the Crane Co., but also rules the Bureau of Standards.

THE METRIC SYSTEM OR FINE AND IMPRISONMENT

In his February, 1919, comment Mr. McEachren said:

"4. Advocates of the metric system do not favor its 'compulsory' adoption.

"5. It is not proposed by the Shafroth bill, nor by any pro-metric body, to take any statutory measure to extend the use of the metric system under present conditions."

Again the representative of the Crane Co. is wrong. Here are typical statements by prominent advocates of the metric system:

David Molitor, third vice-president of the American Metric Association, signed in 1908 a report to the American Society of Civil Engineers which closed with these words:

"The Congress should assert its authority in clear and unmistakable language that from and after a certain date (not over five years from date of passage) the international metric system shall be the only lawful standard throughout the United States, its territories and possessions, and that failure to comply with this act shall be punishable by fine or imprisonment or both, as the court may direct."

Dr. G. F. Kunz, president of the American Metric Association, at the meeting of that organization on Dec. 27, 1916, said (italics mine):

"I believe it entirely feasible to arrange legislation either by optional use of the two systems of weight and measure *for a certain term of years* or by *temporary* exemption of certain types of machinery."

Fred R. Drake, chairman of the executive committee of the American Metric Association, who is carrying on a pro-metric agitation among the grocers of the country, had this to say on April 10, 1916, in a letter to the members of the National Wholesale Grocers' Association:

"Our campaign is educational now, looking to its eventual compulsory legislative adoption by Congressional enactment."

The Shafroth bill contains this provision, making the metric system compulsory in the departments of the Government after Jan. 1, 1920:

"On and after the first day of January, nineteen hundred and twenty, all the departments of the Government of the United States, in the transaction of all business requiring the use of weight and measurement except in completing the survey of public lands, shall employ and use only the weights and measures of the metric system."

It also contained this provision:

"On and after the first day of January, nineteen hundred and twenty-two, the weights and measures of the metric system shall be the legal standard weights and measures of and in the United States."

The last clause would accomplish one of the objects for which the metric agitators in the Bureau of Standards are striving, namely, to make the metric system what it is not now, the standard of the United States.

Mr. Frederick Brooks, speaking before the Boston Society of Civil Engineers, said (italics mine):

"An executive order by the Secretary of the Treasury might establish the metric system *whether the people liked it or not* in exclusive use in the customs houses on short notice."

Mr. Alfred W. Parker, speaking before the Boston Society of Civil Engineers, said:

"I think it would be a good idea for Congress to set a date on which the system will be compulsory."

A bill (H. R. 151) introduced in Congress by Representative Dillon contains this provision:

"Sec. 4.—That any person, corporation, company, or association who shall use, or offer and attempt to use, in any industrial or commercial transaction in the sale or purchase of any commodity any other weights and measures than those of the metric system on and after July first, nineteen hundred and twenty-four, shall be guilty of a misdemeanor, and upon conviction thereof in any court of competent jurisdiction shall be punished by a fine of not more than $500 or by imprisonment for not more than three months, or by both such fine and imprisonment."

Mr. McEachren's knowledge of the intentions of his associates is as limited as his willingness to publish the facts established by his opponents.

Mr. McEachren also said in the same comment:

6. "It (opposition to the metric system) is bound to be swept aside by the march of events."

7. "Because that usage (widest practicable use of the metric system) is inevitable, we are not in the least concerned about any temporarly opposition."

That is mere prophecy, a source of error as fruitful as it is unnecessary.

Only one of the seven statements was correct:

1. "The metric system has been lawful in the United States for more than fifty years."

We find Mr. McEachren here commenting on an anti-metric statement he has ventured to print. And what is the result? Two of his seven statements are mere prophecy; four, erroneous; and only one correct. An exposure of the errors in his comment on the resolutions of the National Association of Manufacturers was sent to Mr. McEachren with a request that he print it. Up to date he has as usual suppressed what he does not want to print.

WHEN COMPULSION IS NOT COMPULSION

In the April, 1919, issue of the Crane Co.'s organ Mr. McEachren discourses on the question, "What is Compulsion?" in which he refers to an earlier statement by him that he (the Crane Co.) does not advocate the adoption of the metric system by compulsory methods. He occupies nearly two pages in trying to demonstrate that a compulsory law is not a compulsory law when enacted by Congress because we live under a government by the majority.[1] Under the McEachren conception of our form of Government no United States law can be compulsory. That of course is nonsense, but it is part of the metric fallacy on which the Crane Co.'s metric policy rests.

[1] Mr. McEachren's demonstration that compulsion is not compulsion is given on page 129.

CHAPTER XXV

A RATIONAL WEIGHTS & MEASURES PROGRAM

The outstanding features of the present weights and measures of the world are as follows:

1. The universal use of the English system in navigation and sea measurements.

2. The overwhelming preponderance of the English system in manufacture.

3. The overwhelming preponderance of the English system in international trade and commerce, due to the fact that the United States and Great Britain are the chief manufacturing and trading nations.

4. The fact that the forces of trade and commerce have carried the English system to every quarter of the globe.

5. The fact that all the nations investigated use the English system and are perfectly familiar with it.

6. The fact that the people everywhere do not like the metric system and refuse to use it except to the extent to which they are compelled by law.

7. The fact that, because of (6), the attempt to adopt the metric system has been followed by failure after failure.

8. The great similarity of the English and Spanish systems which are substantially identical in structure, where they differ being chiefly in the values of units, this difference, in the case of the most important units in international commerce—those of weight—being, for commercial purposes, negligible.

9. The fact that in five countries of Latin America this slight difference in values of units of weight (one-half of one per cent.) has led to the general adoption of the English values.

10. The fact that German influence which, in the past, has been largely responsible for the propaganda in favor of the metric system, will, in future, be negligible.[1]

All these conditions open up a great opportunity for the unification of the weights and measures of North and South America and the British Empire on the basis of the system which is common to all, because of

[1] According to the 1919 Report of the Weights and Measures Committee of the American Society of Mechanical Engineers, "Alexander Siemens, the leading head and financial backer of the Decimal Association of Great Britain, had been obliged to leave the country because of his German connections."

the identity of structure, while the slight difference of values of the English and Spanish units would avoid all that confusion of thought involved in recasting all conceptions of values that is inseparable from the attempt to adopt the metric system.

Here is a simple, sensible, practicable plan for the promotion of the commercial relations of the two Americas and of the British Empire. Let us give up the chase of this will-o-the-wisp which the nations of the world are always chasing but never catching. Let us consult the experience of the past. Let us recognize that the attempt to adopt the metric system is a failure. Let us work for what is feasible, possible and practicable.

What more sane, simple, sensible, obvious, practical, common sense method of promoting the commerce of the two Americas and of the British Empire is there than this?

Let us unify the weights and measures of the two Americas and of the British Empire on the basis of the system which came to us all from the mother of us all—the Roman Empire—and which is no more English than it is Spanish and no more Spanish than it is English for it is neither. It is Roman.

Nothing could so promote international trade and assure the dominance of the English speaking peoples over Germany in industry and commerce. To promote the English system is to work for the interest of the English speaking peoples; to promote the metric system is to work for the interest of Germany.

It is to be profoundly regretted that, in her present temper in these matters, France must be omitted from such a program. However, in a large sense, France is not a trading nation, while such products as she does export are largely those of highly developed artistic handicraft which have little competition and in which weights and measures play a very subordinate part.

This work has already made a promising beginning. Eighteen years ago the Engineering Societies of Great Britain formed a joint Engineering Standards Committee which published several reports of the first order of importance to British industries. About the time of the War, the scope was extended to an Association and, in recognition of the Committee's splendid work, the Government turned over to the Association all of the standardization work in aircraft and a still further development is in progress, it is understood, in the shipbuilding industry.

Sir Archibald Denny, Bart. L.L.D., is chairman of the Association.[1] As these pages go to press the Secretary, Mr. Charles LeMaistre is present in this country at the invitation of the American Engineering Standards

[1] Sir Archibald has been a member of the American Institute of Weights and Measures from its beginning.

Committee, and has brought the invitation of the British Engineering Standards Association for an Anglo-American conference to promote a unification of screw threads. This invitation has been accepted by the American Engineering Standards Committee and, in turn, the American Society of Mechanical Engineers and the Society of Automotive Engineers have been invited by the Committee to be the sponsor bodies and to confer with the National Screw Thread Commission, appointed by Congress.

There is no thought of doing this on any other basis than the English system. With the engineering societies of the two countries united in the establishment of English system standards, what sense is there in discussing the adoption of the metric system? If the United States and the British Government will join hands in promoting this work, as they have recently joined them in a still greater enterprise, the metric system will soon be relegated to the limbo of forgotten subjects of discussion.

APPENDIX I

THE CHARACTER AND STANDING OF THE OPPONENTS OF THE METRIC SYSTEM WITH SOME OF THEIR CONDEMNATIONS OF IT

The Council of the American Institute of Weights and Measures, which was organized to oppose the adoption of the metric system, contains three Past Presidents of the American Society of Mechanical Engineers, a Past President of the American Manufacturers Export Association, a Past President of the Mining and Metallurgical Society of America, the President of the National Association of Manufacturers and a Past President of the same organization, two Past Presidents of the Society of Automotive Engineers, a Past President of the National Metal Trades Association, a Past President of the Society of Naval Architects and Marine Engineers, the President of the Westinghouse Electric and Manufacturing Co., the President of the Stevens Institute of Technology and the professor of Mechanical Engineering at Yale University. No other American organization can present such a list of names as this.

The Council of the American Metric Association which was organized to promote the adoption of the system contains a wholesale druggist, two wholesale grocers, a professor of pharmacy, a director of a museum, a secretary of a bourse, and an expert in precious stones.

Which of these two bodies would the reader select to determine the industrial policy of this country?

Following are some condemnations of the system from those whose names will command respect:

John Quincy Adams, Past President of the United States:

The substitution of an entire new system of weights and measures, instead of one long established and in general use, is one of the most arduous exercises of legislative authority. There is indeed no difficulty in enacting and promulgating the law; but the difficulties of carrying it into execution are always great, and have often proved insuperable.

The legislator . . . finishes by increasing the diversities which it was his intention to abolish, and by loading his statute book only with the impotence of authority, and the uniformity of confusion.

Thus, then, it has been proved by the test of experience that the principle of decimal divisions can be applied only with many qualifications to any general system of metrology; that its natural application is only to numbers, and that time, space, gravity and extension inflexibly reject its sway. The new metrology of France, after trying it in its most universal theoretical application, has been compelled to renounce it for all the measures of astronomy, geography, navigation,

time, the circle, and the sphere; to modify it even for superficial and cubical linear measure, and to compound with vulgar fractions in the most ordinary and daily uses of all its weights and all its measures.

It is of little consequence to the farmer, who needs a measure for his corn, to the mechanic who builds a house, or to the townsman who buys a pound of meat or a bottle of wine, to know that the weight or the measure which he employs was standarded by the circumference of the globe.

Sir George B. Airy, Astronomer Royal of Great Britain:

In the statements introductory to the proposals for new systems in France, North Germany, and India, very great stress is laid on the discordance in the fundamental units of their customary weights and measures as adopted in different districts of the same empire. These reasons have no force in Great Britain and Ireland, throughout which, whatever difference may prevail as to the multiples in local use, the fundamental units, namely, the yard, the pound, the gallon, are strictly the same.

It is very little important whether the relation between the standards adopted for the different measures (for instance, the mile and the yard) be or be not simple, provided that it be ascertained.

Association of Railway Master Mechanics:

WHEREAS, A bill for the adoption of the metric system in the departments of the Federal Government has been reported favorably to the House of Representatives;

WHEREAS, We consider that the only effect of such a law will be the creation of a government metric system and the continuation of the existing system in ordinary commerce and industry;

WHEREAS, It is evident that the confusion resulting from such a condition of things would be intolerable;

WHEREAS, We believe a change in the system of weights and measures used by the people at large to be impossible; therefore be it

RESOLVED, By the American Railway Master Mechanics Association, in convention assembled, that we condemn all legislation intended to promote the adoption of the metric system in this country.

Babcock Printing Press Manufacturing Company:

We consider the proposition of changing our system of weights and measures to the metric system as no more necessary or desirable than teaching the men in our shop the language of the country in which the machine is to be run.

C. W. Baldridge, Civil Engineer:

The fact that all city subdivisions, land subdivisions and practically all measurements of anything, for record or of permanence, in the United States, are made in the system of which the foot is the unit, would constitute an insurmountable obstacle to the changing of that unit.

A few months' work among the old vara measured Spanish grants of

Southern Texas was sufficient to convince me of the undesirability of changing a unit of measurement.

John H. Ball, Manufacturer of Machinery, Barcelona, Spain:

In regard to the change from English to metric measures, proposed in the United States and being agitated in England, it surely would be a great pity to throw deliberately away the uniformity at present reigning in these countries. After four and a half years in a professedly metric country the English system is still to me the easier. After some forty or more years of the metric system in this country the mixture is, after all these years, an abominable mixture still, and bids fair to continue so for many years to come.

Hon. Mr. Bartlett, Member of Congress:

Let me call your attention to the fact that for nearly thirty years the people of the United States have had the very rare privilege, have had the absolute right, of enjoying and using this marvelous metric system. This, to my mind, is a salient and pertinent objection. This has been on our statute books ever since a certain day in July, 1866, and since that day it has been lawful for the people of the United States to avail themselves of every principle contained in the metric system. Have our people done so? Have they cried out with the eloquence of the gentleman from Pennsylvania that we must abandon these old, pernicious Anglo-Saxon systems of weights and measures and secure the priceless boon of a new Latin system. I say that the very fact that they have not, the very fact of the indisposition of the people of the United States to abandon the system of weights and measures to which they have been accustomed from time immemorial, should justify the denial of the passage of this law.

C. A. Bates, Head of Assessment Division, U. S. Treasury Dept.:

The substitution of any new and radically different system of ascertaining taxable quantities would, until fully inaugurated, naturally result in much confusion and possible loss of revenue. New blanks and regulations would be necessary and new stamps of the required denominations would have to be provided. In a word, the entire basis of our present system of weighing, gauging, marking, and stamping such taxable articles and of computing the tax thereon would be changed. The present rate of tax would be seriously complicated.

So far, therefore as convenience and accuracy are concerned, the present system has all the advantages of the proposed metric system.

Charles E. Billings, President, Billings & Spencer Company:

Large sums of money have been expended to establish standards of such products as screws, bolts, nuts, taps, reamers, gages, and innumerable articles of manufacture. The adoption of the Metric system would throw the entire manufacturing industry of this country into a state of chaos that would result in practical paralysis.

George M. Bond, Specialist in Precision Measurements:

I have had experience in linear work, and consider the English units such as are adopted and have been used for years—the inch, foot, and yard—as tending more to convenience and to economy than would be the case with the subdivisions or the units as represented by the millimeter or the meter.

Rear Admiral Bowles, Chief Constructor, U. S. Navy; from an official communication to the Secretary of the Navy:

The Bureau considers it desirable to lay before you a brief statement of the serious disadvantages that would be incurred by the enforcement of the proposed measure in the Navy Department and particularly in this Bureau.

I am unable to see the ultimate advantage claimed for the metric system. The enormous difficulty of the entire loss of present standards is entirely lost sight of in the mere slight convenience in conversion from one system of measures to another.

Sir Frederick Bramwell, F. R. S.:

I well know the value of decimals, and the indispensable need for their use in many circumstances; but I object to being compelled to use them when they are not needed and are in the way.

I find it easier to state ⅞ths, and to deal with it mentally, than to put it into the form of .875. I do not wish to be restricted by law in the use of my tools.

British Parliamentary Committee on Commercial and Industrial Policy after the War:

Having given very full consideration to the subject, we are unable to recommend the compulsory adoption of the metric system in this country.

In our opinion it is absolutely certain that the anticipated uniformity could not be obtained for a very long period, if ever.

In textiles, British measures are widely recognized all over the world even in metric countries, and in the cotton trade British "counts" have become the standard. By abandoning them, we should jeopardize our supremacy in this respect. Lancashire witnesses are emphatically of opinion that the metric system is unsuitable for cotton manufacture, and they point to the fact that, in metric countries, it has to be modified for that purpose.

The practical argument that its adoption is desirable in order to secure uniformity in the markets of the world has been shown to be unfounded. We are not satisfied by any evidence which has been brought before us that trade has been actually lost to this country owing to the fact that the use of the metric system is not compulsory. . . . To attempt to make the use of the system universal and obligatory in this country would cause great loss and confusion at a particularly

inopportune moment for the sake of distant and doubtful advantages. We are convinced that so far from assisting in the re-establishment of British trade after the war, such a measure would seriously hamper it.

As regards the educational advantages claimed for the change, we have been referred to a statement quoted by the Select Committee of 1895 that no less than one year's school time would be saved if the metric system were taught in the place of that now in use. The information that we have received does not support that statement.

It is often popularly supposed that the introduction of the metric system would render possible the immediate sweeping away of many complicated and varying weights and measures. As we have already indicated, this belief is, in our opinion, wholly fallacious.

We are not convinced that the metric system is, upon the whole, even theoretically superior to the British system, and we are satisfied that the practical objections to the proposed change are such as decisively to outweigh any advantages which are claimed for it.

British Parliamentary Committee Representing the Textile Trades:

The great British textile trades—and more particularly, the cotton trade—are so predominant in the world that similar industries in other countries have had, in the main, to follow their lead and to accept their technical standards. For instance, the "counts" of cotton yarn used in most metric as well as non-metric countries are the English "counts." . . . All calculations of cost are made upon the basis of these lengths and weights and any change would produce for a long time an almost world-wide confusion. Then, the yard is so well known in India and China as to have become the linear measure of foreign trade, and a change to the meter would cause confusion and embarrassment in the largest and most conservative cotton using markets in the world.

An argument of great force against our adoption of the metric system is to be found in the fact that a larger proportion of our textile export trade is done with non-metric countries than with metric countries. The yard is the standard of measurement in almost all the great markets of the East, in the United States, and throughout the British Empire. . . . If our present system is a disadvantage to us in dealing with the minority using the metric system, our metric competitors must find the metric system a still greater disadvantage to them in dealing with a majority not using the metric system.

British Parliamentary Committee Representing the Shipping and Ship Building Industries:

So far as shipbuilding and marine engineering are concerned, we see no reason for the change. That part of the metric system involving the decimal subdivision of time and the right angle is most objectionable, and, if adopted, would most seriously prejudice the interests of navigation.

British Parliamentary Committee Representing the Engineering Trades:

There is no demand from the side of the manufacturer for the abandonment of the inch measure and pound weight and the compulsory adoption of the metric system. . . . There are also two strong reasons among others against any change at the present time. First, that the expense of the change would be so great in replacement of measuring instruments, lathe screws, etc., that the trade could not bear it at a time when its recuperative powers will be so severely taxed.

L. D. Burlingame, Chief Draftsman, the Brown and Sharpe Manufacturing Company:

In the matter of figuring drawings we have had considerable experience, with the metric system in our dealings with foreign countries, and in comparing a large number of drawings we find the English system, with its fractions or decimals, is fully as simple and requires fewer figures than the metric system.

I have made an effort for several months, and I have also, through our mechanical engineers and men who are doing our calculating, sought to find some problem where there would be a saving in our line of work. I failed to find the first problem. Perhaps some of those who have used the metric system quite extensively could show us something, but among our foreign draftsmen, who have been brought up on the metric system, none of them have been able to show us any problem that has come up in our practical work where there would be the least saving by using the metric system.

J. P. Brophy, Vice-Pres. & Gen'l. Mgr., the Cleveland Automatic Machine Co.:

Is there no way that agitation among the general public in this country (and the newspapers ought to take it up) that the rebuke of those who have to stand for this change in our measurement will be so severe that those men in Washington who do not comprehend what a tremendous amount of labor there is attached to the using of the metric system in America, would get wise to the fact that it would be better to stop now before they go any further?

I am speaking here from the standpoint of a manufacturer who knows just what he is talking about.

Certainly if we do not get busy this law will go into effect and then we will have an almost insurmountable job ahead of us. I for one can see from a business standpoint, disaster awaiting us if something is not done to prevent this damaging legislation.

John R. Byron, Cotton Spinner, Manchester, England:

International statistics prove that the combined populations of the countries in which the metric system has been nominally adopted are not equal in number to the population of the British Empire alone.

Our race has uniformity in our manufacturing units, and by one

portion only of the race changing we shall lose that most valuable merit. In all countries where the English language is spoken, where English laws are made, where English freedom reigns, where English customs prevail, there are to be found the manufacturer and the trader using those English weights and measures—and those only—which have assisted in making his manufactures pre-eminent and his commerce world-wide. Those British manufacturers who are actively objecting to the meter are those who have wakened up to the necessity of "running the race" without handicap of any kind. They are determined to retain the freedom they now possess; freedom to use those weights and those measures which experience has convinced them are best suited for their purpose.

Canadian Manufacturers Association:

WHEREAS, National legislation is proposed and is being vigorously urged to substitute the Metric System for our present standards of weights and measures, and

WHEREAS, In the language of the "British Committee on Commercial and Industrial Policy After the War," which exhaustively investigated this proposal,

> "We are not convinced that the metric system is upon the whole even theoretically superior to the British system, and we are satisfied that the practical objections to the proposed change are such as to decisively outweigh any advantages which are claimed for it."

THEREFORE, Be it resolved, that we regard the present period of difficult readjustment from war to peace as a most untimely period in which to discuss or adopt a new system of weights and measures and thus add another to the many trying difficulties of this hour.

(Carried unanimously and with applause.)

Hon. Joseph G. Cannon, Member of Congress:

We have had the legal right to use this system for thirty years. And yet, after thirty years of permissible use of this system, when we think of weights and measures, we think—I was going to say, in English—we think in pounds, or tons, or feet, or inches, as we have been taught. Our people universally understand what those words mean. It has been that way for a long time, and was so before there was any United States. It may be said to run through our literature; and although we have the power to enact this legislation, I do not believe it is in the power of Congress to bring that system into use by statute. If we undertake to legalize it to the exclusion of any other, I think it will beget great confusion, and that we shall subject ourselves to much criticism, without effecting the reform which the gentleman thinks is desirable.

F. E. Cardullo, Instructor in Machine Design, Syracuse University:

In answer to Doctor Stratton's argument that the metric system should be adopted because it is a decimal system we would say that our

own should be retained, because it may be made a decimal system whenever it is of advantage for us to do so, and it may be kept as a binary system whenever we find it of advantage to do that.

Conjoint Board of [British] Scientific Societies concurred in also by the [British] Institution of Electrical Engineers:

I. (*a*) The British system of weights and measures should be retained in general use in the United Kingdom except as modified by II.

(*b*) No modifications of existing units nor any new units should be established.

II (*a*) The British system should be simplified by the abolition of all denominations except the inch, foot, yard, mile; grain, ounce, pound (avoirdupois); cwt., ton; pint, gallon; acre. (We have reinstated the grain because in some trades a smaller weight than a quarter of an ounce is necessary.)

(*b*) It would be very desirable, further to extend the use of the cental instead of the cwt., and the short ton (2,000 lbs.) in place of the long ton (2,240 lbs.).

III The alternative use of the Metric System in statistics and on maps is recommended.

IV In the use of the Metric System the names of intermediate multiples and sub-divisions should be expressed in meters and millimeters.

W. B. Cowles, Vice-President and Treasurer, Long-Arm System Company:

I don't want any physicist or any professor or any astronomer or astrologer from the skies[1] to tell me what will go on in my works. I will tell them. I don't want any government official or any subofficial from our new Department of Commerce and Labor to tell me what it will cost me. I will tell them. I don't propose for a moment to admit that the physicist, the scientist, and the astronomer can tell me anything about my business, because they don't know. And I regard it as an insult as it would be for me to go and dictate to them about their astronomy or their particular science.

Samuel S. Dale (Before Committee on Coinage, Weights and Measures, Mar. 1, 1906):

The Chairman: Do you believe it is worth while to try to unify our weights and measures?

Mr. Dale: Yes.

The Chairman: Along what line?

Mr. Dale: My advice is to drop the Littauer bill because it is calculated to create diversity. Print John Quincy Adams's report on the metric system for general distribution. Investigate the facts regarding weights and measures both at home and abroad. Seek unification by eliminating unnecessary units instead of adding new ones. Make no

[1] The author of this quotation might now add gem expert or wholesale grocer.

important change without consultation with other English-speaking countries. This is not a domestic question. Congress and the President have the power, but they have no right, to adopt any new policy in the control of our weights and measures without consultation with and the concurrence of the British Empire.

H. L. Des Anges, Superintendent, Floating Equipment, Long Island Rail Road:

My experience with the metric system dates from early childhood and first school training, when I had a thorough knowledge of it. A change from the present system of measurement in my mind would work great hardship on the common run of engineers.

Prof. N. F. Dupuis, M. A. F. R. S. C., Dean of Practical Science, Queen's University, Canada:

No one, for a moment, doubts the importance of science as an element in our civilization and a potent force In the modern development of the world. But it is quite possible that past successes have somewhat turned the scientific head, and that the scientist may overrate his ability to regulate advantageously the usages of the manufacturing and commercial world.

However, this may be, it is not the agriculturist, or the manufacturer, or the merchant that clamors for a change to the metric system. But it is manifestly the scientist, who urges on the legislator, and the latter knowing little of the merits of any system, and having confidence in the wisdom of his advisor, and being quite willing to be credited with the appearance, if not able to boast the reality of being truly scientific, is too often ready to impose upon the people some new and radical idea proceeding from the fertile scientific brain without due consideration as to where it may lead.

Rear Admiral Earle, Chief of Bureau of Ordnance, U. S. Navy:

I wish to say that the Bureau of Ordnance of the Navy has never used the metric system and has thus far come across no difficulties which cannot be just as easily solved by the present system of weights and measures as by the use of the metric system.

In view of the tremendous amount of ordnance material on hand, all fabricated according to the English units, I hesitate to predict the results if the metric system was forced upon us.

(The above relates to the suggestion made by the President of the American Metric Association to our War Department when we entered the great War that then was the time to adopt the metric system for our military equipment.)

Engineering Magazine:

The manufacturers of the United States are just beginning to realize that there is now in Congress a concerted attempt, originating, it is believed, in the Bureau of Standards, and vigorously seconded by the Chairman of the House Committee on Coinage, Weights and Measures,

to secure the enactment of legislation leading to the compulsory adoption of the Metric System of Weights and Measures in all departments of the Government, and thence into the entire country.

It is believed that such meddling paternalism needs only to be widely known to be effectively checked; and hence it is here brought to the attention of those most nearly concerned in order to arouse them to vigilance which is the price of liberty.

Engine Builders' Association of the United States:

We believe, if the metric system had possessed any merit, it would have come into use long ago, not by force of law, but by that of expedience. . . . Even granting all the merits that have been claimed for it, a fair statement from a commercial and engineering standpoint is that it offers no marketable improvement.

Ericsson Manufacturing Company, Manufacturers of the Berling Magneto:

Ten years ago we used the metric measures in this plant exclusively, but owing to inability to get American mechanics who could use the metric system, we found it necessary to shift to the English measures and they are now used exclusively by us both for our product for domestic and export manufacture.

H. E. Esterbrook, U. S. Customs Service, Port at New York:

I want to call your attention to the fact that as customs officers throughout the United States we have to deal with this so-called tariff act of July 24, 1897. If your refer to that tariff act you will find the units, pounds, square yards, tons, and feet. Now, if you enact this bill it is necessarily going to cause confusion unless you amend your tariff bill to accord with your present bill. If you will except the customs division of the Government, as you have excepted the survey of the public lands, then I see no objection to your bill, but I can see, in my mind, great confusion. You turn to the cotton schedule of this tariff. The duty is dependant upon the weight per square yard and the cost per square yard and the counts to the square inch.

Now, if we adopt the metric system you upset that to a great extent, which would make it complicated and confused, and the result will be untold lawsuits as to the proper construction of the tariff.

James W. Evans, Metropolitan Inspector of Weights and Measures, Sydney, Australia:

Fortunately we can generally rely upon the common sense of the representatives of the people in the various Parliaments to resist attemps to force upon us a retrogade measure. Should that safeguard fail, however, it is easy to foresee that such a storm would be raised, so much turmoil would be created, every branch of trade would be so disturbed, that practical completion of the movement would never be accomplished.

We have the best system of weights and measures in existence. It is suited to our commercial requirements, long practical employment has proved its value for all trading purposes, it is part of our language, and ingrained in us. Not one sufficiently valid ground has been advanced why we should abandon it for an inferior scheme, and every high consideration of our national welfare bids us to "hold fast to that which is good," and particularly when there is nothing better to replace it.

Furniture Association of America:

WHEREAS, A bill for the adoption of the metric system in the departments of the Federal Government has been reported to Congress with recommendation to passage;

WHEREAS, Such a bill can have but one of two results—the creation of a special system of government weights and measures on the one hand, or a change in the system used in the commerce and industries of the country on the other;

WHEREAS, A special government system of weights and measures would be as absurd as a special government system of currency, and,

WHEREAS, A change in the weights and measures used by the people at large, can only be accomplished at great cost, after generations of confusion and with no adequate compensating advantages, therefore be it

RESOLVED, By the Furniture Association of America in convention assembled, that we condemn this bill as wholly mischievous in its tendencies.

RESOLVED, That we condemn all legislation to bring about a radical change in our system of weights and measures.

Chas. S. Ginrich, Cincinnati Milling Machine Company:

The people of the earth who trade—that is, a majority of them—are using the English system to-day, so that the logical system of commerce should be the English system. But I want to bring out another point. I have had personal experience with the company I am with in dealing with foreign nations, and we are to-day sending a large amount of our product into France and Italy. They do not ask us for a metric machine. In fact, they accept machines made to our standards, and they have gone further and have filed with us a standard specification in regard to arbors which states that all arbors going with machines must be made to English measurements; in other words, they want the English (or American) standard arbor.

E. Sherman Gould, Civil Engineer:

Let me premise by saying that I belong to the class which perhaps has the best right to form and express an opinion on the subject, having used both the English and metric systems in a somewhat extended engineering practice at home and abroad, beginning with my education in a French engineering school.

If we were to adopt the metric system, even admitting for the argument that it is better than ours, we would not find our work of measuring, recording and calculating materially lessened. Long calculations would be as troublesome and as liable to error as ever, and probably the majority of people, not specialists in any particular art, would be unable to say which they preferred, after a fair trial.

F. A. Halsey, Commissioner, American Institute of Weights and Measures:

The humor of the situation is that whereas at the beginning of the hearings in Washington (before the House Committee on Coinage, Weights and Measures) the adoption of the metric system was urged because it would better adapt our manufactured goods to the needs of foreign customers, the conclusion of the hearings found the metricists fairly falling over one another in their efforts to show that the adoption of the system would make no change in these goods.

In the machine shops of South America—of which there are more than most people realize—39.3 per cent. of the machine tools are American, 43.2 per cent. are British and the remaining 17.5 per cent. are German, Belgian and French. We are always told that South America is metric, South American shops have the world from which to buy, and they choose machine tools made to English over those made to metric measures in the ratio of nearly 5 to 1. Moreover, commercial Germany has long been splendidly represented in South America, while we have never been and Germany has had ample shipping and banking facilities which we have not.

Another illustration, known to all, is found in the vast export trade in American automobiles, which go to, and are equally acceptable, in all countries, metric and nonmetric alike. No one knows, asks or cares to what system of measurements their parts are made, and the same is true of steam engines, mining, agricultural and other lines of machinery.

The matter is as broad as it is long. If our goods are not acceptable in metric countries because of the units used in making them, metric goods should for the same reason be unacceptable here. We import vast quantities of such goods, but no reader of these pages ever heard the question raised. We buy these goods without thought or question regarding the system of measurements used in their construction.

Willet N. Hayes, Assistant Secretary, U. S. Department of Agriculture:

The bill reads "That from and after the 1st of July, 1908, all of the Departments of the Government of the United States, in the transaction of business requiring the use of weight and measurement, shall employ and use the weights and measures of the metric system." Now, we would like to know just what those words, "in the transaction of business," mean. In other words, would it affect our bulletins that

we publish and send out to the people of this country? We might as well go out of business if we tried to put our bulletins in the metric system.

H. A. Hazen, Chief, U. S. Weather Bureau:

The metric system usually carries with it the centigrade scale on the thermometer, and here the whole English-speaking world should give no uncertain sound. In meteorology it would be difficult to find a worse scale than the centigrade. The plea that we must have just 100 degrees between the freezing and boiling points does not hold; any convenient number of degrees would do. The centigrade degree is just twice too large for ordinary studies. The worst difficulty, however, is in the use of the centigrade scale below freezing. Any one who has had to study figures half of which have minus signs before them knows the amount of labor involved. To average a column of 30 figures half of which are minus takes nearly double time that figures all on one side would take, and the liability to error is more than twice as great. I have found scores of errors in foreign publications where the centigrade scale was employed, all due to this most inconvenient minus sign. If any one ever gets a "bee in his bonnet" on this subject and desires to make the change on general principles it is very much to be hoped that he will write down a column of 30 figures half below 32°F., then convert them to the centigrade scale, and try to average them. I am sure no English meteorologist who has ever used the centigrade scale will ever desire to touch it.

Sir John Herschel:

The change, if we make it must be complete and thorough. And this is in the face of the fact that England is beyond all question the nation whose commercial relations, both internal and external, are the greatest in the world, and that the British system of measures is received and used, not only throughout the whole British Empire but throughout the whole North American continent, and (so far as the measure of length is concerned) also throughout the Russian Empire.

Samuel Higgins, Mechanical Superintendent, Southern Railway:

Freight cars, as you know, are away from home a great deal. For instance, a car belonging to the Southern Railroad will spend a great deal of its time on other lines. The object of having standards in the construction of these cars is to facilitate their repairs when they are away from home. For instance, a car may be built and owned by a railroad in California and finds its way over to the State of Pennsylvania. The car inspector going over that car in Pennsylvania will find something missing; for instance, a nut is lost off the end of a bolt. All he has to do is to go to his little storeroom and he will find some standard size of nut in there that will fit that bolt. He applies the nut to the bolt and the car goes on and there is very little delay to freight.

The way the mechanical railroad men look at this matter is that

the use of the metric system will for the time, at least, destroy all present existing standards. Some men will argue that the change can be made quickly; I claim that it will take at least a century to bring about these changes, and I base that upon the experience in France, where the metric system originated. In France they still use our system for screw threads. They use it in Germany, and if they have not been able to bring about a complete change in one hundred years I do not see how we can expect to do it.

J. E. Hilgard, Assistant, U. S. Coast Survey. From an official communication to the Superintendent of the Coast Survey:

It is indeed difficult to see how an obligatory statute could be executed in this country. We would hardly undertake to suppress the use of the inch, pound, and gallon by penalties, as has been done under the parentally despotic governments of Europe, where, as in Prussia, fine and imprisonment followed the possession of the old standard.

Not only are lands purchased from the public domain described in a simple decimal system of acres measured by square chains and decimals, but all the most valuable real estate, such as lots and streets in cities, has been laid off in this country in even feet, generally even tens of feet, as 50, 60, 80, 100, 150, etc. What adequate motive is there to change these expressions into terms which are necessarily fractional, and in which those foreign nations whose convenience it is proposed to meet have no conceivable interest? What useful purpose is subserved by designating a building lot 24 by 120 feet in the form of 7.315 by 36.576 meters?

Sir Joseph Hooker:

The complaint of horticulturists and gardeners concerning the Centigrade thermometric scale is

1. That the degrees are too large for their purpose, requiring the use of fractions.

2. That in a climate where for so many months the temperature hovers about the freezing point, the frequent necessity of the plus and minus signs is a great inconvenience.

Walter Renton Ingalls, President, Mining & Metallurgical Society of America, President, American Institute of Weights and Measures:

From a project that would manifestly put the weights and measures of the greatest industrial nations in the world at sixes and sevens, it must be evident that the result would be more discord instead of more uniformity.

In laboratory work, I use grammes and cubic centimeters, or kilogrammes and litres both out of convenience and out of early habit in common with that of most chemists.

In the railway business, it is well known that the passenger and freight schedules which fill great volumes are based on cents per mile, and cents

per 100 pounds. The railways have complained over the great expense involved in making alterations for the purposes of the Interstate Commerce Commission. What would it be if the entire fabric had to be torn apart and rewoven in order to please the advocates of the metric system?

Consider what we do when we get a drawing of a French construction, let us say a metallurgical furnace, to build in this country. The first thing that has to be done is to redraw it, not for the reason that it is expressed in metric measurements, but for the reason that it calls for constituent parts of sizes that are not obtainable here.

We have volumes of tables of figures devoted to the properties of structural steel. Similarly, as to mechanics, hydraulics, surveying, in brief all the branches of engineering. With the metric system, these would be all but useless.

Considering the Indo-European race alone, there is a much larger population that does not use the metric system than does, and their nations are far superior in industrial development, measured by iron production, let us say, to all other nations combined.

With respect to confusion, the skirts of the metric system are not clean. As a statistician of nearly thirty years' experience, I may say that I have fallen into more errors over the zentners and doppelzentners of metric Germany, and the quintals and metric quintals of Chile, than I have over the pounds of England and America.

All of our systems, including the metric, are undergoing evolution, conforming to the requirements and practices of people, generally in the direction of simplicity. Most of the old English measures to which the metricists point with such scorn are obsolete. Nobody hears now-a-days of the coomb, the pottle, the chaldron, the palm or the barley-corn. The perch, the puncheon, the span, the tierce and the toise are all but forgotten. Even the furlong, the gill and the rod are disappearing.

I remember the time when I was in favor of its adoption in the United States, and it was not until I studied the matter more carefully that I changed my mind.

Iron Age:

Certainly no news from the United States could give much greater joy in Berlin than that this country had decided to use from now on nothing but the metric system in manufacturing its military equipment. Probably the suggestion shows nothing more than ignorance of the complications of manufacturing, and ignorance of the disastrous effect of a wholesale change in shop standards.

(The above relates to the suggestion made by the President of the American Metric Association to our War Department when we entered the great War that then was the time to adopt the metric system for our military equipment.)

K. E. Keller, Vice-President, Westinghouse Machine Company:

I understand that the compulsory metric bill is now under consideration by your committee. We again wish to place ourselves on record

with you as being unalterably opposed to this bill. We believe that such a law would cause most unjust and unreasonable loss to manufacturers, due to the enormous cost of changing drawings, patterns, tools, and equipment, to say nothing of the infinite loss in business while such changes were in process. It would be a sad commentary on the intelligence of our legislators in Congress to permit a few scientists and misguided parties to bring about a compulsory metric system that would be forced upon manufacturers where the cost would be so great and the benefits almost entirely negligible.

Dean William Kent, Professor of Mechanical Engineering, Syracuse University:

I wish to touch only one phase, which has probably not been considered to any great extent by the men who have hitherto appeared before the committee. I refer to the inconceivable magnitude of the task of wiping out or translating into metric measures the English literature based on the English inch and foot, and the enormous number of records in manufacturing establishments based on the English measurements.

The big job, however, would be to produce the literature of the transition period. It would include, in the tables of beams, for instance, all the existing standard sizes, in even inches of depth, with their corresponding metric equivalents to the nearest tenth of a millimeter, together with the dimensions, both English and French, of length, breadth of flange, and thickness of web, the weight per yard and per meter in pounds and kilograms, and the coefficients for computing strength in both systems. Besides this, there would have to be new tables of the new sizes, 20 to 600 millimeters in metric measures, and their English equivalents.

During the transition period the mechanical articles in the Encyclopedia Britannica, and all other cyclopedias and other works of general reference, would have to be printed in the transition language, otherwise they would not be readable to the people of the period. When the reform(?) was at last accomplished they would have to be reprinted again, making them altogether metric, and then the old books would all find their way to the paper mill.

The engineers' pocketbooks would also have to be reprinted in the transition language, and then many years later completely metricised. Every present owner of one of these pocketbooks, if the metric system is coming very soon, would have to provide himself with both of the new books, and the transition book would be half as large again as the present book, and of course would sell at a higher price.

Even if the metric system were far superior to the English system, which it is not, and even if it were possible to enforce it by compulsory legislation, which it is not, the enormous cost of introducing it, the vast trouble and confusion it would cause during the transition period for at least two generations, the abandonment of our mechanical standards, upon which are based the present system of interchangeability of parts

of manufactured articles, the making worthless of the greater portion of our technical literature, make the price too great to pay for any advantage, real or supposed, of the metric system.

B. G. Lamme, Chief Engineer, Westinghouse Electric & Manufacturing Company:

I am satisfied that probably 90 per cent. or more of the calculations in our engineering department would not be simplified or materially affected by the use of the metric system. It would be a mistake to change to the metric system in our engineering department until such system is adopted as standard in our manufacturing departments. To change the system a little at a time would lead to serious confusion.

Henry M. Leland, President, Lincoln Motor Company, Past President, Society of Automobile Engineers:

Any change to the metric system in the manufacture of these (the Liberty) motors would involve difficulties and delays so serious as to border on disaster.

(The above relates to the suggestion made by the President of the American Metric Association to our War Department when we entered the great War that then was the time to adopt the metric system for our military equipment. Mr. Leland's company produced 6000 Liberty motors.)

Library Bureau:

Our draftsmen and mechanics failed to make any attempt to familiarize themselves with the metric system, but simply translated the metric dimensions into English inches or fractions thereof, and worked accordingly. I do recall, however, having known one man connected with the Library Bureau in former days who was inclined to brag that he had mastered the metric system sufficiently so that he could actually think in it as well as he could in feet and inches, but I take it that his was a very rare case.

(The Library Bureau abandoned the system after giving it a trial of more than thirty years' duration.)

J. H. Linnard, Naval Constructor, U. S. Navy:

I may say that I am not unfamiliar with the metric system. The Government sent me abroad for four years to study in France, that is to learn my profession as a naval architect. I spent four years in the French government schools. Necessarily, my studies were carried on in the French language and with the French system of measures. I have a certificate as a French naval architect from the French government schools.

As far as calculations in the matter of shipbuilding are concerned, it is just as convenient in every way, shape and form to use English measurements as French.

William Lodge, President, the Lodge and Shipley Machine Tool Company:

This (the direct cost), however, would be only a small part of the resulting confusion, by reason of our being absolutely obliged to continue the present system for all product that has been shipped to date, and which is liable to be in use in many cases up to 50 years from date. The advantage to be obtaind seems to us to be so trifling that we should put it at a very low figure indeed.

Hon. David Lloyd-George, President, British Board of Trade:

It is rather significant that after 100 years of compulsory metric measurement the Minister of Commerce in France has been obliged to appeal to traders to assist him in carrying out the law, not by means of compulsion, but by means of inducing traders to use the legal standard.

It has been pointed out that the greater proportion of our foreign trade is with non-metric countries, and if we change our system to the metric system without arranging a similar change in our Colonies, and without inducing the United States and the East to come into a general arrangement, we should deprive ourselves of an advantage which we have at the present moment over our metric competitors. I know it is said that we lose trade in the metric countries at the present moment, because we do not sell on a metric basis. I do not agree.

Major F. A. Mahan, U. S. Army:

Although he is an earnest partisan of the system, which he has used freely for thirty years, he always finds difficulty in thinking in the system. Stating resistances in kilogrammes per square centimeter conveys no meaning to his mind; it is necessary to convert the expression into pounds per square inch.

(The above remarks by Major Mahan were made before the Société des Ingénieurs Civils de France. They are given as they were reported, in the third person.)

Manufacturers of the Cincinnati district to the number of thirty:

Of the millions of dollars of machine tools which the members of the Association have sold to France and Germany, the great majority have been sold without request or suggestion that any of the dimensions be made in accordance with the metric system. The only changes that have been asked for have been in occasional measuring and adjusting screws. In view of this experience and of the unexampled growth of the export trade of this country during the past half-dozen years we cannot see any need of changing for the benefit of foreign trade.

We believe that the difficulties of the change have been ridiculously underestimated, and that the metric system offers no compensating advantages. We regard the whole matter as a shop affair exclusively, since the confusion and expense must be borne by the shops. We therefore regard the intrusion of those who have no pecuniary interest in shops, as unwarranted.

A. M. Mattice, Consulting Engineer:

The relation between linear measure and weight applies only to water, and fresh water, not to salt water; not to ships.

In the drafting room of a manufactory the draftsmen are always computing weights for balances, strengths, and costs. They may use one material instead of another on account of weights. Suppose I have a rail or rod of iron, and its area is 8 square inches. What is its weight per yard? An inexperienced man would multiply by the weight per cubic inch, and finally get it. But all you have to do is to bring your decimal point one place to the right and you have it. Ten times the area of cross section of wrought iron is the weight per yard in pounds exactly. It is not an approximation, but exact. That one little fact is of more importance to the metal manufacturers of this country than the relation between the meter and the volume of fresh water, because it is being used by hundreds where the other is being used by one person.

Walter M. McFarland, Acting Vice-President, Westinghouse Electric and Manufacturing Company:

Having approached the subject originally with an inclination for the metric system, after repeated conferences with progressive engineers and manufacturers, I cannot see where, for our business, there would be any advantage whatever in the adoption of the system. Meanwhile, the cost of making the change would be in the neighborhood of a million dollars.

It is too often forgotten, when referring to the logical relation between the units of weight and length, that while the unit of weight is that of a cubic decimeter of water, which would enable us immediately to get the weight of any volume of water by simply expressing it in cubic decimeters, in the vast majority of engineering calculations we do not deal with the weight of water at all, but with the weight of other substances whose specific gravity is represented by an irregular number. The result is that in the metric system the cubic contents have to be multiplied by this number to get the weight, which is exactly what is done when, in the English system, the cubic contents are expressed in cubic feet or cubic inches. The multipliers are just as simple in the latter case.

Study of the printed testimony before the committee shows that, with few exceptions, those who advocate the adoption of the metric system are men who have nothing whatever to do with making things, but only measuring them after they are made.

Manufacturers do not object to anybody using the metric system who finds it more convenient. We do object most strongly, however, to having chemists, astronomers, and others,[1] who know absolutely nothing of the details of manufacturing, try to dictate to us how to run our business.

The claim is made that we now have a great confusion of units and ratios, all of which will be removed by adopting the metric system.

[1] The author might now add gem experts and wholesale grocers.

To this the answer can be made with absolute certainty that such will not be the case. We shall simply add the metric units to the others. This has been the history of France and Germany, in the former of which the metric system has been in use over a hundred years.

For about forty years it has been legal for any one who so desires to use the metric system. Why has it made so little progress if it has such advantages as its friends claim?

Manufacturers have shown again and again that they are ready to abandon old methods and adopt new ones, even at great expense, when there is some benefit in doing so.

We have to-day men connected with our company who have been brought up, so to speak, in the metric system, and then came to work in the English measures, afterwards going back to our French factory; yet notwithstanding their early training these men have found it, on account of the possession of the data in English measure, more convenient to make their calculations and to work in the English system. I have emphasized these things to show why the reasons ordinarily assigned as arguments in favor of the greater convenience of the metric system do not apply in manufacturing, so that we do not see any advantage to us on that score.

Col. E. D. Meier, President, Heine Safety Boiler Company, Past President, American Society of Mechanical Engineers:

Every man in our workshops, from the superintendent down to the rivet boy, is used to thinking in feet and inches, and you would have to make him over again before he could get used to figuring in a foreign measure.

Quartermaster General M. C. Meigs, U. S. Navy. From an official communication to the Secretary of War:

The metric system is not a convenient one for common use. The true scientific natural basis of the metric system has been abandoned. The meter is quite as arbitrary and unscientific a standard as the foot or yard, and its compulsory adoption would derange the titles and records of every farm and every city and village lot in the United States; would put every merchant, farmer, manufacturer, and mechanic to an unnecessary expense and trouble, and all, it seems to me, for the sake of indulging a fancy only, and a baseless fancy, of closet philosophers and mathematicians for a scientific basis of measures and weights which is not what if professes to be.

Rear Admiral Melville, Chief Engineer, U. S. Navy:

The metric system is entirely academic. It is a perfect system for the laboratory, but it would ruin the business of Great Britain and America. We had better attempt to adopt a universal language.

To the unprejudiced person the public testimony must have shown with unmistakable clearness that the scientific men were not actuated by a desire to ascertain the truth, for the reason that after indisputable facts have been presented by competent experts as to the enormous

cost and inconvenience of making a change, they continued merrily to assert that the change would cause little inconvenience, and so small a cost that both could be waved aside.

Spencer Miller, Chief Engineer, the Lidgerwood Manufacturing Company:

Should the metric system be adopted as the standard by the United States government the utmost confusion would prevail for a long period. . . . The confusion incident to the adoption of the metric system by our Government would be so great that there would be an emphatic demand for the repeal of the law.

National Association of Machine Tool Builders:

The experience of Germany, in which the old measures are still in large use, has shown that the change cannot be completed even after a generation of confusion.

The sale of many million dollars' worth of machine tools has been made abroad, by members of this Association, especially to France and Germany, without requirement or request by the purchasers for changes in general construction, to conform to metric measurements, the only changes being in adjusting and measuring screws, the great majority of machines needing no changes whatever.

The adoption of the metric system would entail an enormous first cost of new equipment to conform to the new standards and a constant increased cost in the maintenance of a double standard for repairs and renewals, and a consequent increased cost of the product to the consumer.

National Association of Manufacturers:

WHEREAS, the agitation for the adoption of the metric system, has been again revived and is being vigorously conducted, and,

WHEREAS, the British Committee on Commercial and Industrial Policy after the War has made an exhaustive analysis of this question and concludes in language as follows:

> "We are not convinced that the metric system is upon the whole even theoretically superior to the British system, and we are satisfied that the practical objections to the proposed change are such as to decisively outweigh any advantages which are claimed for it."

THEREFORE, Be it resolved, that we regard the agitation for the establishment of the metric system as particularly untimely because of war taxation on manufacture, and because under present conditions the overwhelming activity of manufacturers in war work makes proper consideration of such a subject impossible.

It is further resolved, that we endorse the work of the American Institute of Weights and Measures in opposing the adoption of the metric system.

National Metal Trades Association:

WHEREAS, The renewed agitation for the adoption of the metric system has reached the danger point and called into being the American Institute of Weights and Measures to combat it; and

WHEREAS, The National Metal Trades Association is in full sympathy with the object of the American Institute of Weights and Measures;

RESOLVED, That the Association make application for Association Membership in the Institute;

RESOLVED, That we urge all our members to lend their coöperation to this work by joining the Institute as Corporation Members.

Napoleon:

The merchants and citizens found themselves perplexed in the most ordinary affairs; this contributed still more to making unpopular an administration that placed itself beyond reach of the people, ignoring their necessities, breaking violently with their popular customs, like a Greek or Tartar conqueror, who, with uplifted rod, exacts unquestioning obedience to his will, which he allows his prejudices and his selfish interests to control, ignoring those of the vanquished.

It is a tormenting of the people for mere trifles.

C. P. Patterson, Superintendent of U. S. Coast Survey. From an official communication to the Secretary of War:

The problem of a change of the kind proposed in a great commercial, agricultural, and manufacturing country like our own is vastly more difficult than it would be in nations the larger portion of the inhabitants of which deal only in a limited manner with small quantities. This subject has been a matter of much thought to myself for several years, and the more I have heard it discussed the more convinced I have become that a matter so grafted into the daily habit and thought of the whole people can only be changed by, as it were, the slowest absorption and that not less than thirty-five years will be required to effect even a semblance of a change.

Some enthusiasts earnestly believe, taking counsel of their own earnestness and hopefulness, that a complete change could be effected throughout the country in, say, from five to ten years; but we have only to remember the length of time it has required for the decimal coinage, the most facile of all standards to change, to obtain universal acceptance and usage in all parts of the United States. In some places, to this day, after a hundred years of trial, we occasionally hear that eight shillings, or six shillings, or four and sixpence "make a dollar;" and only a few years since we heard of "picayunes" and "bits," which respectively were worth 6¼ cents and 12½ cents.

Charles T. Porter, Past President, the American Society of Mechanical Engineers:

But, say the metricians, we want uniformity. Well, in the English system of linear measurement we have uniformity. It presents the very

ideal of uniformity. Throughout the United States and the British Empire, all English-speaking people on the globe, in their great variety of occupations, every man who measures any thing for any purpose, all employ the same identical system of measurement. Its great practical excellence has compelled its universal adoption by men free to use the metric or any other system if they want to, and with the same freedom of choice this excellence will make its use universal.

Potter's Materia Medica:

Although this progress is aided by every process of forcing which scientific bodies can bring into action, with all the influence brought to bear in its favor it certainly has not yet been adopted by any considerable proportion of native-born and home-educated physicians and pharmaceutists. One of its greatest difficulties for the physician is the want of fluid denominations below the milliliter corresponding with the decigram, centigram and milligram of the weight scale. Its chief disadvantage is one that is inherent to any decimal system—that the number ten cannot be divided more than once by any integer without producing a fraction.

Providence Association of Mechanical Engineers:

WHEREAS, Renewed attempts are being made to bring about the adoption of the metric system of weights and measures through its enforced use in the departments of the Federal Government;

WHEREAS, We regard a change in the system of weights and measures used by the people at large to be practically impossible, thus making a change by the government alone, uncalled for, therefore be it

RESOLVED, By the Providence Association of Mechanical Engineers, that we condemn this law as one that will introduce further diversity and confusion, especially affecting linear measures;

RESOLVED, That we regard the proposed legislative action affecting our established system of weights and measures as unwise.

Dr. Jacques W. Redway, F. R. G. S., Geographer, Meterological Observer:

In 1872–3, while working in a laboratory of quantitative analysis, I came in contact for the first time with the gram and its subdivisions. During a period of student work covering several years, practically all my determinations were made in grams and milligrams, or else with burette measurements expressed in cubic centimeters. In the following five or six years I made a special study of the metric system. The theory was so logical that the subject became extremely fascinating. More than once I was accused of having a fanatical obsession and I must confess that the charge was not without truth. During this period I was an instructor in metallurgical chemistry in a university and my reputation as a specialist in the metric system had grown to the extent that I was frequently invited to address audiences on the subject. I likewise became a member of the California board of education and

in this capacity was an important factor in the passage of a state law that made the teaching of the metric system compulsory.

To make their task easier I gave our corps of teachers a course of instruction, at the same time providing the schools with the various units. At the end of three years, however, it was the concensus of opinion among teachers that the time required to insure a reasonable proficiency in the metric system was about equal to that required for an equal proficiency in the English weights and measures.

In time, I became an assayer and metallurgical chemist—chiefly in gold and silver ores. For this work the metric system lasted about one week. Why? Because of inconvenience and the time required to make the arithmetical reductions. Thereafter, a miniature ton based on the number of Troy ounces in a ton gave me the exact number of ounces of metal expressed in grains and decimal subdivisions. It was merely a matter of convenient magnitudes and least amount of computation.

After more than a third of a century in laboratory work, I use practically two metric units. In burette measurements the cubic centimeter is well-nigh indispensable—not because of its relation to the metric system, but because it is a very convenient magnitude. A vacuum pump the gauge of which expresses the degree of exhaustion in millimeters is a part of the equipment of many laboratories, but the millimeter has no advantage over the decimal subdivision of an inch in expressing exhaustion; indeed, I should much prefer the latter unit as more convenient.

And here is the crux of the whole matter. The units and subdivisions of the English system are founded on convenience and they continue in use because they are convenient.

When a unit of magnitude has ceased to be useful it has been dropped from use. Such terms as ell, link, barleycorn, and span are scarcely more than a memory. This is also the case with the stone, the drachm (except in fluid measurement), the Troy pound, the scruple, and the quarter; the Troy ounce and the fluid ounce are unknown outside the prescription room. Practically the only ounce that ever comes into one's life is the one-sixteenth part of a pound and its subdivisions may be expressed quite as readily in decimals as in halves, or in quarters.

Ever since human beings have dwelt upon the earth, halves and quarters, and not tenths and hundredths have been the natural bent of the human mind.

In the work of this laboratory, temperature and pressure measurements enter into almost every sort of computation and, for many years, I used the centigrade scale. In the course of time, however, making and recording temperature observations for the Weather Bureau became a part of my regular work. The illusionment of the centigrade scale had been pleasant; the disillusionment came very promptly, and in a very short time. I resumed the use of the Fahrenheit scale for all my work. Why? Simply to save time. The unit of the centigrade scale is nearly double that of the Fahrenheit scale and is inconvenient. In order to

preserve the degree of accuracy required, an additional column of figures is required. Between the estimation of fractions and the computation of them, the work of thermometry is doubled.

The English system of weights and measures represents the evolution of human necessities. Every unit and its subdivisions was born of a specific requirement. The metric system is purely arbitrary; and if its units and subdivisions have any relation to human needs, the relation is purely accidental. One querist asks the very pertinent question—What virtues has the meter that the yard has not? The answer is, if you have a big tank of water, the measurements of a meter stick reduced to cubic decimeters will indicate the weight of the water in kilograms—provided, of course, that the temperature of the water is reduced to 4°C. And this exhausts the list of advantages.

In the metric system one arbitrary unit has been created with the expectation that it will meet all demands. This unit is the meter. It is assumed to be the ten-millionth part of the earth's quadrant; but it is not. It is likewise assumed that the earth is an oblate spheroid; but it is not. It is assumed that the standard meter rod exactly represents the calculated meter; but it does not. It is also assumed that the kilogram is the exact weight of a cubic decimeter of water under given conditions; but it is not. The liter is assumed to be a cubic decimeter; but it is not. Not one base unit of this "scientific" system conforms to definition. What then, is the basis of the metric system? It is merely an arbitrary lineal unit that stands for nothing.

Let us see some of the consequences of an enforced adoption of the metric system:

1. About two thousand Weather Bureau stations and substations will require equipment, and the instruments do not now exist. This, however, is a matter that may be overcome. The equipment may be purchased in Germany;

2. About forty million school books will be needed to replace those now in use. Mathematical and geographic texts will require re-writing;

3. Lineal measures, weights, weighing scales, and measures of capacity for the needs of one hundred millions of people would be required. They are not now in existence;

4. By far the most important factor at the present moment is the effect that a change of systems will have on tools of precision and tool-making machinery—lathes, lathe gears, milling machines and their accessories, rules, drills, jigs, gauges, screw-thread cutting gears, and similar machinery for precise work. At the present time there are not enough in the United States to equip a single shop. Where can they be had? Well, they are "made in Germany."

We are now entering upon the greatest struggle for humanity that has occurred in the history of the world. We are in dire need of ships, of guns, of small arms, and of the munitions of war. Six million tons of shipping, one hundred thousand aeroplanes, two thousand field guns of heavy caliber, one million stand of small arms, half a million projectiles a day for the next six months for our own army, and one

million a day for our Allies are needed without delay. Famine is shaking its spectral finger in the face of the whole world, and man-saving machinery must be created to do the work of men whose lives have been the price of our salvation. A million men of our own flesh and blood will soon be in the field—targets for Hunnish bullets.

And yet in this fearful crisis, when every minute of delay means the sacrifice of brave lives, a few well-meaning gentlemen demand that all this work must conform to a discredited unit because the unit is theoretically a ten-millionth part of the earth's quadrant.

About forty years have elapsed since the metric system was legalized in this country, and about forty years ago instruction in the subject was made compulsory. At the end of four decades, the metric system in this country survives only in chemical and physical laboratories. It is used in these mainly because the gram weights are "made in Germany." Why, oh why, in this crisis, then is the demand made for its compulsory use of the metric system? Is it, too, "made in Germany?" Certainly nothing that could occur in this country would give greater satisfaction in Berlin than its enforced adoption.

(The concluding paragraphs above relate to the suggestion made by the President of the American Metric Association to our War Department when we entered the Great War that then was the time to adopt the metric system for our military equipment.)

A. S. Robinson, Civil Engineer:

We find that the 20 meter station already makes 50 per cent. more work over the American system on the level notes and profile, correspondingly increases the liability to error, introduces still another liability to error in figuring grades, and presents no improvement over the American system.

In running curves by deflection angles, fractional stations fall more frequently on even feet than on even meters, and therefore the engineer has more "trouble with those annoying and distracting decimals of a degree" in the metric than in the foot system.

(This quotation refers to railroad surveying in Mexico.)

Dr. Coleman Sellers, Consulting Engineer:

By changing our unit of lineal measure for the sake of uniformity with France we should sever our uniformity with Great Britain, a country with which three-fifths of our foreign commerce is transacted.

If new weights and measures are to be adopted all the scale beams in the country must be regraduated and readjusted; the thousands of tons of brass weights, the myriads of gallon, quart, and pint measures, and of bushels, half bushels, and peck measures, and every measuring rule and rod of every description throughout the land must be thrown aside, and others, must be substituted.

The great mass of English technical literature would become almost useless and must be translated from a language which we, and the nation

we have most to do with, understand perfectly into a new tongue which is strange to most of our people.

The measurements of every plot of ground in the United States have been made in acres, feet, and inches, and are publicly recorded with the titles to the land according to the record system peculiar to this country. Hundreds of years would elapse before we could permit ourselves to forget these old measures.

Coleman Sellers, Jr., President, Wm. Sellers & Company:

Our experience of over forty years' use of the French metric system in one of our departments has shown us no superiorty, for shop purposes, of that system over the English, and we have not been encouraged to extend its use. Did it possess practical advantages such as claimed, it would be to our interest to use it throughout our works.

William Sellers, President, William Sellers & Company:

The proposition to change our system for the sole object of conformity with a system which in this particular has not even been accepted in metric countries, is absurd, and could only emanate from men utterly ignorant of the conditions required, and of the necessary apparatus to fulfill them.

We have now a well-established system, not only for the form of every detail of these indispensable articles, but also for their manufacture, so that the parts will be interchangeable. We have attained to a system superior to any other the world affords, and we are now threatened with a law, which, if adopted, will make it necessary to abandon all that we have accomplished, and to what end? Not that there is any other system better than ours, but solely that we may conform to another system of metrology which does not lend itself to such constructions, so that even metrical countries have only succeeded in introducing confusion after a century of effort to displace our system based upon the inch.

The manufacturers, as a rule, do not talk much. They manufacture; but the scientific people, who are purely scientific, think they know what the manufacturer needs a great deal better than he does himself.

William Sellers & Company who have been in export trade 60 years:

Notwithstanding the large volume of foreign inquiry we receive, so little of it calls for adherence to the metric system as to be practically negligible.

Henry D. Sharpe, Treasurer, Brown & Sharpe Manufacturing Company:

Mr. Sharpe gives the following table of drawn steel shafting as an illustration of the plan of the metric party, that we continue to make things to present sizes but measure them in millimeters or, as put by the Secretary of the American Metric Association: "Whatever is

manufactured must be actually the same size or weight as before. It is merely a matter of a new term of expression." This or similar tables apply to all standardized articles of manufacture.

English, Inches	Metric, Millimeters	English, Inches	Metric, Millimeters	English, Inches	Metric, Millimeters
1	25.4	1 3/8	34.9250	1 3/4	44.4500
1 1/16	26.9875	1 7/16	36.5125	1 13/16	46.0375
1 1/8	28.575	1 1/2	38.1000	1 7/8	47.6250
1 3/16	30.1625	1 9/16	39.6875	1 15/16	49.2125
1 1/4	31.7500	1 5/8	41.2750	2	50.8000
1 5/66	33.3375	1 11/16	42.8625		

Society of Naval Architects and Marine Engineers:

WHEREAS, A bill for the adoption of the metric system in the departments of the Federal Government has been favorably reported to the House of Representatives:

WHEREAS, We consider that the only effect of such a law will be the creation of a government metric system and the continuation of the existing system in ordinary trade and industry;

WHEREAS, The confusion resulting from such a condition of things would be intolerable;

WHEREAS, We believe the adoption of the metric system of weights and measures by the people at large to be impracticable, therefore be it

RESOLVED, By the Society of Naval Architects and Marine Engineers, assembled in annual meeting, that we condemn all legislation intended to promote the adoption of the metric system in this country.

The Solvay Process Company whose drawings used in the construction of the first plant came from Belgium and were in the metric system:

As the workmen in this country were not used to these measures, it became necessary to translate them into the foot and inch system. In many cases this was done by using 40 inches for the meter which gave even inches. We have stuck to the foot and inch for measurements because it was too much of a task to educate all of our workmen to the other system.

Ellis Spear, Commissioner of Patents; from an official communication to the Secretary of the Interior:

The history of the Mississippi Valley affords a practical illustration of the difficulty of substituting one system of land-measurement for another. It is well known that the early French settlers of St. Louis and vicinity laid out their land in arpents. Since that time, the territory has passed from French into Spanish hands, and from Spanish to our own. It has been for nearly three quarters of a century American

soil. The French settlers have become merged with the immigrants from the East and Europe that have filled the Mississippi Valley. Old customs have disappeared, and the few lingering reminders of French occupation are cherished by the antiquarians with almost as much tenderness as if they were relics of Assyria or Babylon. But to-day there is scarcely a piece of real estate in the vicinity of St. Louis that is not measured in arpents. It is so advertised, so sold, and this word lingers in the speech of the people, and the area it indicates lingers in their daily transactions with a tenacity that nothing appears to shake. Now there is nothing in the arpent which makes it a more convenient unit of measurement for land than the acre. But its retention under the circumstances is something more than a question of mere habit or use. It is because all real estate transactions are matters of permanent record, and permanent records are only changed with great difficulty. To change them involves translations, tedious and accurate computation, the discarding of original records, and opens the door to mistakes and fraud; and the possibilities of these are without end.

For a little district of a few square miles along the Mississippi River now substitute the area of our nation with its vast estates, its little farms, its villages, and town lots, all measured by acres, its great cities in which ground is measured minutely down to fractions of an inch, and consider the vast and costly records in which the titles to all this property is set forth. Consider the area of our Western States and Territories, where under the existing Congressional surveys the divisions into townships, sections, quarter-sections, etc., have become not only matters of record but actually enter into the social and political life of the people.

If three-quarters of a century have done so little to obliterate the system of land-measurement at St. Louis under the existing circumstances, what period would be required to change the present received system of the entire country to the one proposed? Left to the operation of natural causes, it is safe to say it would never be done. Were there compensatory advantages, the authority of government might be exerted to bring about such a change; but there are none. Even the facility of calculation so sought for disappears in view of the long array of figures and fractions necessary in translating the terms of one system into the terms of the other. There is nothing to compensate for the hardship and the danger that would ensue from such a change.

Herbert Spencer:

It has always been an astonishing thing to me that the advocates of decimalization do not perceive that its only advantage is in computation. In every other process it is a detriment.

Ten thousand persons intend to make twenty million persons change their habits. The ten thousand are the men of science (by no means all), the Chambers of Commerce, and the leaders of some Trade-Unions—leaders only, for the question has never been put to the vote of the mass. The twenty million are the men and women of England, with those

children who are old enough to be sent shopping. Ten thousand is an over-estimate of the combined bodies who are forcing on the Metric System, and twenty millions is an under-estimate of the numbers to be coerced.

And this is to be done among a people who say they are self governed!

What has happened on the New York Stock Exchange? Are the quotations of prices in dollars, tenths, and cents? Not at all. They are in dollars, halves, quarters, eights; and the list of prices of American securities in England shows that on the English Stock Exchange quotations are not only in quarters and eights, but in sixteenths and even thirty-seconds. That is to say, the decimal divisions of the dollar are in both countries absolutely ignored, and the division into parts produced by halving, re-halving, and again halving is adopted.

There lies before me an imposing list of the countries that have followed the lead of France. It is headed "Progress of the Metric System." It might fitly have been headed "Progress of Bureaucratic Coercion." When fifty years after its nominal establishment in France, the metric system was made compulsory it was not because those who had to measure out commodities over the counter wished to use it but because the Government commanded them to do so; and when it was adopted in Germany under the Bismarckian régime, we may be sure that the opinions of shopkeepers were not asked. Similarly elsewhere, its adoption has resulted from the official will and not from the popular will.

If and when, within ten years after my death, a Bill shall be introduced into Parliament for the compulsory adoption of the metric system of weights and measures, I desire that my pamphlet, entitled "Against the Metric System," shall be reprinted and that such reprinted pamphlet shall be distributed gratis, and at the expense of my estate, among members of both Houses of Parliament, and shall be put on sale by my publishers at a nominal price.

(The last paragraph is an extract from Mr. Spencer's Will.)

Standards Committee of the Society of Automotive Engineers:

In view of the fact that the Army and Navy Departments are not both in favor of adopting the metric system and further in view of the necessity of arriving at standards that will mean the least possible delay in the production of airplane parts, this division recommends definitely the use of the English system of measurement except in isolated cases, such as spark plug threads where the metric system is desirable in order to effect interchangeability with some well-established standard.

(The above is a reply to the suggestion made by the President of the American Metric Association to our War Department when we entered the great War that then was the time to adopt the metric system for our military equipment. The recom-

mendation of the Standards Committee was adopted, even to the extent of changing the dimensions of the Caproni airplane from metric to English figures, but, nevertheless, Metric News of July 10, 1917, published by the American Metric Association, states that: "The United States Government are using the metric system almost exclusively in the manufacture of aeroplanes.")

Hon. J. C. Stevenson, Member of the British Parliament:

I am told that in Germany they have adopted it. I believe that that is intended; but what was their position? A confusion of standards of weights and measures, which must be got rid of at any cost, especially to carry out the purpose of a united empire. In seventeen states of Germany the foot is of sixteen different lengths.

When the Bill was discussed in 1863 and 1864, Mr. Ewart and the advocates of the change asserted that if the system were made permissive, and contracts made legal in it, its great advantages would recommend themselves, and the people would demand a compulsory Bill. These expectations have been wholly falsified. There is less movement for the metric system than ever; and the people of this country are utterly careless about it.

The audacious statement is made that "there is at present no uniformity whatever in the weights and measures at present in use." On the contrary, there are no countries in the world which are further advanced than Great Britian and the English speaking nations of the world in this respect. All our measurements are absolutely uniform, for there is only one foot and inch and yard.

I maintain that these difficulties (in foreign trade) have been enormously exaggerated and, moreover, that the persons on whom they fall are those who can most easily overcome them—to whom they are least a difficulty. Foreign trade is in wholesale transactions; goods are imported in large quantities or cargoes, and the simple arithmetical operation necessary for converting the weight is done only once for the large quantity—and yet to save trouble to the merchant's clerk who makes this calculation, all the shopkeepers who sell the articles in the minutest detail, and their customers who buy the smallest quantities, are to be perplexed and worried by the compulsory introduction of utterly unknown and unintelligible ideas into the concerns of their daily life.

H. H. Suplee, Author, Supplee's Mechanical Engineers' Reference Book:

The situation in the United States and Great Britain to-day is absolutely different. Industries such as the world has never before seen have been built up, and have sent their products all over the world. And every steel section rolled, every plate turned out, and every wire drawn, every engine and dynamo and machine tool, every pipe and

shaft and bolt and nut, is based upon the inch and the foot, units wholly incommensurate with the metric ones. The screw-threads of England and America are standard all over the world, and they are wholly inconvertible into any metric expression which could be used as a guide or practically reproduced by a workman. If all these measurements must be changed into metric equivalents the *things* themselves must be changed; to believe that we could go on making them as they are now, and gauging them by the new system of measurement, is to cherish a mischievous delusion. . . . The years of earnest and costly effort, and the millions of dollars spent to secure interchangeability, and standardization, would be wrecked and marked for the scrap heap by the first compulsory legislation enforcing the use of the Metric System upon our manufacturers. And it would take more than fifty years of endless confusion and double-standard working to clear the deplorable and expensive wreckage out of our shops.

Dr. John E. Sweet, Founder and Past President American Society of Mechanical Engineers:

The men who deal in ideas wish to dictate to the men who deal in things; the mathematician wants to fix things for his convenience at the expense of the convenience of the workman, while there are one hundred workmen to every mathematician, and the mathematician gains nothing in money, while the workmen will be put to millions of expense, and will not only receive no benefit, but so long as our present books exist, and so long as things now made endure to be required, the double set of tools must exist; and every one reading an old book will have to translate the figures to comprehend or use the results."

F. W. Taylor, Founder of the Taylor System of Scientific Management, Past President American Society of Mechanical Engineers:

The fact that it does not come into general use proves that it cannot go upon its merits.

Let every man have it if he wants it, but let no set of men be forced to use it merely because a lot of scientific men, who have not studied its working in our shops, wish to arbitrarily force it upon us. I use it myself. But for every time that I use it once, or any scientific man uses it once, every machinist in the United States bumps up against it a hundred times a day and all day long. The inch, half inch, quarter inch, five-eighths, thirteen-sixteenths, three-fourths, and seven-eighths are the machinists' property, their asset. They belong to the machinist, and for his use they are vastly more convenient and simpler than the metric millimeter ever could be.

Hon. R. W. Thompson, Secretary of the Navy:

It may be assumed that a more general intercourse will exist between peoples speaking a common language than between peoples who speak different languages. And looking at the present geographical extent of the countries wherein the English language is used, and the importance

of their commercial intercourse, and also its future importance, as compared with any other of the spoken languages, at a period not at all remote, if regarded historically, it would seem to be of doubtful expediency to separate ourselves from what is now common in weights and measures with other people who speak our language, and with whom it is desirable to increase rather than diminish our commercial intercourse. Experience would indicate that we should hold ourselves in accord with them, rather than adopt other standards, however, theoretically advantageous, for it will be impossible to escape many practical disadvantages if our standards vary from theirs, so long as our intercourse shall continue.

Henry R. Towne, President Yale & Towne Manufacturing Company, Past President American Society of Mechanical Engineers:

Originally I believed that the adoption of the metric system would be a benefit to us and should be promoted. I held that opinion for a good many years, during which I had no occasion to study the subject from a practical point of view or carefully. Accident led me to take it up seriously some years ago, and as I began to study it and to try to understand the effect of the proposed change on the country my opinion began to change, and the more I have studied the subject, the more convinced I am that for this country to change from the English base to the metric would be a national misfortune.

Since 1866 it has been permissible, under the laws of the country, for any one to use the metric system if he pleases, and transactions based upon it have been legal; yet the mechanical industries of the country to-day are not using the metric system, I venture to say, in one-tenth of 1 per cent. of their operations. If there was this alleged benefit to be derived from it, why have not those industries voluntarily availed of it? Instead, they have rejected it. Surely this fact is proof that the change is not needed for the fostering of our exports trade.

The law of 1866 entitles all who prefer the metric system to use it. Let them be content with the liberty of choice which they enjoy without seeking to deprive the rest of us who think otherwise from the enjoyment of an equal liberty.

The argument to change, briefly stated, is that for the sake of getting international unity we shall sacrifice national unity and accept internal and national confusion.

No other country has it (uniformity) to-day, and no country has ever had it, except the United States and Great Britain. We have uniformity throughout this land. You ask us to discard it and to substitute confusion. We ask you to desist. We have to-day, barring the measures of volume, absolute uniformity throughout the United States and the entire British Empire, throughout commercial China, and largely throughout Russia, whereas in all of the so-called metric countries the old units still persist, and in most of them the measures used by the people are not metric at all.

If we adopt the metric system, even for Government use only, we thereby destroy our present unity and substitute confusion. We would have the people of this country talking one language and the Government of the people talking another language in things that vitally concern both.

To-day from one end of the land to the other, and throughout the whole British Empire, we have an absolute, identical, uniform standard of length. The thing France wanted, the thing Germany wanted we have. For us to do at this stage, under present conditions in this country, what France did in 1801 and Germany in 1871, is to reverse the process and to substitute for a uniformity of standards, which they sought to obtain, a multiplicity of standards where we have already uniformity.

I was in the city of Cologne, in Germany, last summer, and in a hardware shop on the leading street there—I happen to remember the name, Schmidt & Meldan—I looked at what we could call a 2-foot rule, which is there, of course, the meter. On one side was the meter and millimeter, on the other feet and inches. What foot and inch? You are asked that question over the counter. Do you want the Rhenish inch or the Westphalian inch or the Dresden inch? They have three foot measures in use in that one locality, together with the meter.

You have got either to maintain existing absolute sizes, and state those sizes in metric terms, in which case we get decimals running into seven, eight, nine, or even ten places, some of them, with all the interminable array of figures which that involves, and the resulting danger of error and inaccuracy, or else, to get the full advantage of the metric system, you have got to change your actual sizes into the nearest equivalent in metric measurements. But when you have done the latter, you have destroyed all of your existing implements of measurements, you have made it impossible for work to interchange between old and new machines, and you have subjected yourself to the vast expense of duplicating your entire equipment of gauges and special tools.

The scientists and theorists, in the goodness of their hearts, seem to think they know better what is good for us in our own business than we know for ourselves.

University Convocation of the State of New York:

CONSEQUENCES OF MAKING THE PROPOSED CHANGE

1. It would strike out from the English language every word and phrase and sentence used in connection with our present units of weights and measures, and would impose the necessity of learning a new language for the one now in use:

2. It would blot out from the knowledge of the nation all apprehensions of distance, and area, and volume, acquired through the present units, and would render necessary the acquirement of similar knowledge by less convenient units, having different relations to each other, and expressed in a new and unknown language:

3. It would extinguish all knowledge of money values, now so familiar to the entire population in their daily purchases, and sales and barters, for those values are all adjusted with reference to the units of weights and measures: and

4. It would change the records of our entire landed property, requiring them all to be translated into a new and foreign language. Should all this be done merely to change one standard from 36 inches to 39.37 inches, when both standards are determined, substantially, in the same manner?

War Department, Office of Chief of Ordnance:

Replying to your letter relative to the use of the metric system in the manufacture of ordnance material:

It was, of course, immediately found that the English and metric systems not being commensurate, the metric dimensions could not be accurately transferred to the drawings. In order to avoid any confusion on this point, the drawings were first issued with metric dimensions only. It was found, however, that in the shops the workmen required the English units and the drawings have, it is believed, quite generally been changed to show the English unit with the metric. This is the practice now followed in this office in issuing new drawings.

War Department, Watervliet Arsenal:

The drawings for the 155 mm. gun, originally in metric dimensions, were translated into English dimensions by the Engineering Bureau, of the Ordnance Department. Our workmen will use English dimension micrometers.

(The above relate to the suggestion made by the President of the American Metric Association to the War Department when we entered the Great War that then was the time to adopt the metric system for our military equipment.)

E. O. Way, Chief Inspector of Weights and Measures, Dominion of Canada:

The use of metric weights and measures in Canada is practically nil and less in our Quebec Province than any other.

(The above in reply to the claim made by the World Trade Club that "the large French population of Canada has greatly increased the use of the metric system there.")

Dr. William C. Wells, Chief Statistician Pan American Union:

It would be unfortunate if the answer to this question be involved with the question whether or not American industry should or should not change from the English to the metric system. Everyone recognizes that there is a connection in the matter of measure between our domestic manufacture and the export trade more or less direct but it is much less direct than is ordinarily believed. Sometimes the measure

counts, and sometimes it does not. The list where measure does not count or scarcely ever acts as a handicap is broader than potatoes, apples, or coal oil. Such examples are padlocks, watches, clocks, sewing machines, typewriters, cash registers and the like.

The problem, however, is different when you come to consider the extent to which English measures, have penetrated Latin American countries. This extent is much greater than the advocates of the metric measures in the United States are willing to admit.

In many cases the penetration of the English measure is a matter of long standing. If it were possible for lumber manufacturers to put metric measure lumber into Latin American markets it might prove to their advantage. Then, again, it might not. Where American or English monoply exists, English measures are received, and it probably would not be wise to change.

This penetration . . . . is particularly in evidence in Cuba and Mexico. In Cuba it has extended to a remarkable degree. Even the Cuban statistical publications show sugar exports in pounds, not kilos. (And note that according to the Director of the Bureau of Standards, the metric system is "obligatory" in both Cuba and Mexico.

Willans & Robinson, Rugby, England:

This firm was for many years cited as an illustration of the successful use of the metric system in an English machine shop. About 1906 they abandoned the use of the system, so far as they could, after it had once fastened its tentacles upon them, and in explaining the reasons for thus abandoning it, they say:

We are satisfied, after a long practical trial, that such advantages as are to be obtained by the use of the metric system in an English machine shop, are too dearly purchased . . . The tenth of a millimeter is of no use to anyone; it is like the proverbial goose, "too much for one, not enough for two;" consequently, for clearances on our metric work we always figured up the drawings in thousandths of an inch.

We are making new lines of work to the English dimensions, and are satisfied that the adoption of the metric system by this firm has cost us a great deal in gauges and special tools, without adequate return.

J. A. Williamson, Commissioner of the Land Office; from an official communication to the Secretary of the Interior:

The system now in use in surveying and subdividing the public lands, with the modifications that have been suggested by experience, has controlled the public-land surveys for a period of ninety years. Under it some seven hundred millions of acres, lying in twenty-eight States and Territories, have been surveyed, and of these many millions of acres remain undisposed of.

The modifications which would necessarily follow the adoption of the meter in place of the unit of measure now in use would mainly arrest the

subdivisional work, by requiring the use of the centare, are, and hectare in superficial measures, instead of the acre, which is the sole unit of superficial measure now in use in land surveys.

As the unsold lands are mingled with those already disposed of and patented, they cannot be resurveyed. If the proposed obligatory law should go into effect, it is evident that the labors of this office in disposing of lands, the subdivisions of which are governed by two different systems, must be very considerably increased.

The Gunter chain, so long used in this branch of the public service, is of the convenient length of 66 feet. It furnishes a unit of linear measure twenty times greater than that of the metric system—a unit that accords with the magnitude of the operations in which it is employed. This measure is readily adapted to ancient surveys, in which the pole or perch was used. It determines the statute mile without division of its parts.

The 80 chains of the mile divide into suitable parts without fraction, and the subdivisions of lands produced thereby are equally free from the disadvantage of fractional parts of the acre.

The legal township of the United States land surveys is approximately a rectangular tract, with sides of six statute miles. This body of land is divided into 36 sections, with sides of 80 chains, each regular section embracing, as nearly as may be, a square mile, or 640 acres.

In setting off the aforementioned tracts by the metric system, the sides of the township—six miles—would measure 9 kilometers, 6 hectometers, 5 decameters, 6.083 meters.

The sides of the sections—80 chains—would measure 1 kilometer, 6 hectometers, 9.347 meters.

The contents of a section, now briefly expressed "640 acres," would be 258 hectares, 99 ares, 98.41 centares.

The contents of the convenient and briefly described quarter-section of 160 acres, expressed in terms of the metric system, would be 64 hectares, 74 ares, 99.6 centares.

It will, I trust, be seen from the foregoing that the substitution of the meter for the convenient unit now used in land surveys is not likely to promote the interests of this branch of the service. On the contrary, the effect will be to increase its labors and expenses, and to cause great inconvenience to the public for many years to come, and these embarrassments seem to be unbalanced by any corresponding advantage.

J. A. Wood, Architect:

I am as conversant with the metric system of measurements as with the English system of feet, inches, etc., I have used it in making plans to be used in Spain, Belgium, Cuba, Brazil, and Buenos Ayres.

In employing foreign draftsmen brought up to the metric system and accustomed to it, I find their work contains more errors than when plans are made on English scales.

In Spain and in all the Spanish and Portuguese countries, with which I am familiar, the workmen receive the general plans as they

are made, but in doing the work first reduce and make the detail or working plan to a scale of feet and inches (pies and pulgadas) and yards (varas). Usually, but not always, Spanish feet and inches, which are one-twelfth shorter than English feet, while nearly all machinery in those countries is required by the users to be measured in English feet and inches.

In land survey in Spanish countries I find many errors, and on close investigation I find they are nearly always tenths, hundredths, etc.

Much inconvenience to 90 per cent. of the native mechanics of the country would be the result. The same would be the case with all land surveys.

The law would be a dead letter, the same as it is in Spain and Spanish countries, and to a great extent is still in Germany. The feet, inches, yards, rods, miles, etc., will continue to be the measures in general use.

APPENDIX II

Following are the names of the firms and individuals who supplied the returned questionnaires which are summarized in Chapter II.

ARGENTINA

National City Bank Branch	Buenos Aires
E. Resentry (?)	Rosario
D. Meyer & Cia	Bahia Blanca
Ramose Abilla	Vircuman
Santiago Egli	Mendoza
Donald Campbell	E. Carbo Entre Rios
W. Sidwell	Posadas
Allan B. Lea	Buenos Aires
Ensor H. Blanchard	San Isidro
Minister of Agriculture	
Louis Dannerald	Mendoza

BRAZIL

Pramca y Martines	Sao Paulo
A. Haas	B. Huyinte
Ohliger & Co	Manaos
Banco do Natal	Natal
David Cameiro & Co	Coritiba
Banco Hsp. e Agricola	Bello Horizonte
Fas Scrapa & Fichos	
Tancredo Porte & Co	Manaos
M. F. Do Monte & Co	Mossoro
National City Bank Branch	Santos
Banco Commercio de P A	Rio Grande
Salgado Rogers & Co	Ceara
Berringer & Co	Para
Companhia Mogyana	Campinas
Bernardo A de F Hermanos	Goyas
Luiz Baptista, Jr	Sao Paulo
Jose Henriques Duarte	Sao Paulo
Armando Annes & Co	Passo Fundo
J. B. Stewart, American Vice-Consul	Pernambuco
Director of the Estrada de Ferro Central de Brazil	
Montesth & Co	Pernambuco
Theodore Sampaio	Bahia
Dr. Francisco Texeira de Silva Tilles	Santos
American Consulate	Para
J. P. Ferras	Sao Paulo
Luiz Barretto Filho	Sao Paulo
C. F. Deichman, American Consul	Santos
Geo. H. Pickenell, American Consul	Para

EDWARD HIGGINS, American Consul.....Bahia
ALFRED L. MOREAU GOTTSCHALK, Consul General.....Rio de Janeiro
L. O. MUNCH.....Porto Alegre
CHAS. L. HOOVER, American Consul.....Sao Paulo
F. I. RIBERIRS DE CASTRO.....Rio de Janeiro
MIGUEL PRESGRAVE.....Santos
MANOEL CARNEIRO DE SANZA BANDEIRA.....Rio de Janeiro
UNDECIPHERABLE.....Florianopolis
PRAENCAR MATHUS.....Sao Paulo

CHILE

BANCO ESPANOL DE CHILE.....Antofagasta
BANCO ESPANOL DE CHILE.....Iquique
BANCO ESPANOL DE CHILE.....Valdivia
Y. E. S.....Cordoba
JOHN STERETT GITTINGS, JR., Commercial Dept., Valparaiso Branch of the National City Bank.....Valparaiso
W. R. GRACE & Co.....Punta Arenas
THE COQUIMBO AGENCIES Co.....Coquimbo
JOHN R. BRADLEY, American Consul.....Punta Arenas
ALBERTO FAIT & Co.....Punta Arenas
MARK R. LAMB.....Santiago

COLOMBIA

SOCIEDAD DE AGRICULTURES DE COLOMBIA.....Bogota
CAMARA DE COMERCIO DE BOGOTA.....Bogota
UNITED FRUIT Co., Chas. W. Sinners, Mgr.....Santa Marta
O. E. GUYANT, American Consul.....Barranquilla
UNITED FRUIT Co., Ahanino Klacio, Agent.....Barranquilla

COSTA RICA

C. P. CULLEN.....Limon
BENJAMIN F. CHASE, American Consul.....San Jose
SALV. CERDA.....San Jose

CUBA

UNITED FRUIT Co.....Preston
GEO. B. STARBUCK, American Vice-Consul.....Cienfuegos
LIBORIO ALVIRA.....Cienfuegos

ECUADOR

J. G. WHITE & Co.....Guayaquil
J. A. CLEVELAND.....Guayaquil
F. W. GODING, American Consul General.....Guayaquil
THE GUAYAQUIL AGENCIES Co.....Guayaquil
BANCO DEL ECUADOR.....Guayaquil
LOUIS A. PLAZA.....Guayaquil

GUATEMALA

LEON GUTTMAN & Co.....Guatemala City
RODRIGO MALINA.....Guatemala City
ANTONIO TEJEDA A.....Barberena
C. M. SHAW, Division Manager, United Fruit Co.....Puerto Barrios
TOPKE & Co.....Guatemala City

MEXICO

Norton F. Brand, American Consul	Salina Cruz
W. W. Graham, British Vice-Consul	Durango
Stephen E. Aguirro, American Consul	Ciudad Juarez
G. K. Donald, American Consul	Aguascalientes
Walter H. Sholes, American Consul	Nuevo Laredo
Francis R. Stewart, American Consul	Vera Cruz
Andres Gomez y Orejan	Vera Cruz
Gaylord Marsh, American Consul	Yucatan
W. E. Chapman, American Consul	Sinaloa
American Consulate	Frontera, Tabasco

NICARAGUA

Andrew J. McConnico, American Consul	Corinto
Max Sacora	Rivas
Ignacio Cardoze	Masaya

PANAMA

A. G. Snyder, American Consul General	Panama
Aroslmena Hermanos	Panama
J. M. Kyes	Bocas del Toro
American Trade Developing Co	Panama
G. A. Alvarado, Municipal Weights and Measures Dept	Panama

PERU

D. Dasso	Callao
Carlos Basadre y G	Lima
Emilioran Oordt	Lima
Arequipa Agencies Co	Arequipa
Piura Agencies Co	Piura
W. R. Grace & Co	Lima
The Salaverry Agencies Co	Salaverry

PORTO RICO

Finley, Weymouth & Lee, Inc	San Juan

SAN SALVADOR

Fernando Sagren	San Salvador

SPANISH HONDURAS

Francis J. Dyer, American Consul	Tegucigalpa
Chas. N. Willard, American Consul	Ceiba
Lahi Culotta	Puerto Cortez

URUGUAY

National City Bank Branch	Montevideo
C. Perez Monteio y Ca	Montevideo
Reyuser y Taulmnat	Montevideo
William Dawson, American Consul	Montevideo

VENEZUELA

Banco Commercial de Barranquilla	Barranquilla
Karl Blashitz	Caracas
Homer Brett, American Consul	LaGuaira
Frank Anderson Henry, American Consul	Puerto Cabello
Emil Sauer, American Consul	Maracaibo

APPENDIX III

Following are the names of the firms and corporations who answered the questionnaire and whose answers are summarized in Chapter III. From this list some undecipherable signatures are, of necessity, omitted. Signatures of the type, *John Doe, Supt.*, with nothing to signify of what he is superintendent are also omitted. Questionnaires so signed have, however, been counted because filled out in good faith.

Anchor Sawmills Co. ..... Memphis, Tenn.
American Steel Foundries ..... Chicago, Ill.
American Clay Machinery Co. ..... Willoughby, Ohio.
American Encaustic Tiling Co., Ltd. ..... Zanesville, Ohio.
American Sterilizer Co. ..... Erie, Pa.
American Locomotive Co. ..... New York, N. Y.
American Felt Co. ..... Boston, Mass.
American Shoe Polish Co. ..... Chicago, Ill.
American Pulley Co. ..... Philadelphia, Pa.
American Pad & Textile Co. ..... Greenfield, Ohio.
American Multigraph Co. ..... Cleveland, Ohio.
American Mason Safety Tread Co. ..... Lowell, Mass.
American Machinery Co., Inc. ..... Philadelphia, Pa.
American La-France Fire Engine Co. ..... Elmira, N. Y.
American Hardware Corporation ..... New Britain, Conn.
American Fork & Hoe Co. ..... Wallingford, Vt.
American Chicle Co. ..... New York, N. Y.
Alphaduct Co. ..... Jersey City, N. J.
Alpha Portland Cement Co. ..... Easton, Pa.
Allbright-Nell Co. ..... Chicago, Ill.
Ahlstrom Piano Co. ..... Jamestown, N. Y.
Acid Proof Iron Products Co. ..... Newark, N. J.
A. &. J. Manufacturing Co. ..... Chicago, Ill.
Automatic Machine Company ..... Bridgeport, Conn.
Artic Ice Machine Co. ..... Canton, Ohio.
Atlas Ball Co. ..... Philadelphia, Pa.
Acme Steel Goods Co. ..... Chicago, Ill.
Alliance Knitting Mills ..... Whitesboro, N. Y.
Armstrong Cork & Insulation Co. ..... Pittsburgh, Pa.
Adam Electric Co., Frank ..... St. Louis, Mo.
Automatic Electric Co. ..... Chicago, Ill.
Alabama Co. ..... Birmingham, Ala.
American Hoist & Derrick Co. ..... St. Paul, Minn.
Autocar Company ..... Ardmore, Pa.
Automobile Crank Shaft Corp. ..... Detroit, Mich.
Auburn Wagon Co. ..... Martinsburg, W. Va.
American Soda Fountain Co. ..... Boston, Mass.
Abrasive Company ..... Philadelphia, Pa.
American Chain Co. ..... Bridgeport, Conn.

Ames Shovel & Tool Co. ..... Boston, Mass.
American Wire Fabrics Co. ..... Chicago, Ill.
American Thermos Bottle Co. ..... Norwich, Conn.
American Smelting & Refining Co. ..... New York, N. Y.
American Die & Tool Co. ..... Reading, Pa.
A. P. W. Paper Co. ..... Albany, N. Y.
Acme Rubber Co. ..... Trenton, N. J.
Autophone Co. ..... Ithaca, N. Y.
Atlantic Steel Co. ..... Atlanta, Ga.
Art Wall Paper Mills ..... Chicago, Ill.
Art Metal Construction Co. ..... Jamestown, N. Y.
Arnold Print Works ..... North Adams, Mass.
Appleton Wire Works ..... Appleton, Wis.
Andrews Wire & Iron Works ..... Rockford, Ill.
Anderson Engine Co. ..... Chicago, Ill.
American Tube & Stamping Co. ..... Bridgeport, Conn.
American Transformer Co. ..... Newark, N. J.
American Tap & Die Co. ..... Greenfield, Mass.
American Rolling Mill Co. ..... Middletown, Ohio.
American Steam Gauge & Valve Mfg. Co. ..... Boston, Mass.
Aurora Tool Works ..... Aurora, Ind.
American Tool & Machine Co. ..... Boston, Mass.
American Gas Furnace Co. ..... Elizabeth, N. J.
Allith Prouty Company ..... Danville, Ind.
Armstrong Bros. Tool Co. ..... Chicago, Ill.
Alaska Packers Association ..... San Francisco, Cal.
American Oak Leather Co. ..... Cincinnati, Ohio.
American District Steam Co. ..... No. Tonawanda, N. Y.
Atlas Lumber Co. ..... Seattle, Wash.
American Sheet & Tin Plate Co. ..... Pittsburgh, Pa.
American & British Mfg. Co. ..... Bridgeport, Conn.
Anniston Steel Co. ..... Anniston, Ala.
Aermotor Co. ..... Chicago, Ill.
Avery & Sons, Inc., B. F. ..... New York, N. Y.
Archbold-Brady Co. ..... Syracuse, N. Y.
American Brake Shoe & Foundry Co. ..... Mahwah, N. J.
Aluminum Goods Mfg. Co. ..... Manitowoc, Wis.
American Cast Iron Pipe Co. ..... Birmingham, Ala.
American Stove Co. ..... New York, N. Y.
Atlas Tack Co. ..... Fairhaven, Mass.
American Lava Co. ..... Chattanooga, Tenn.
Allison Co., W. D. ..... Indianapolis, Ind.
Avalon Knitwear Co. ..... Utica, N. Y.
Abbott Laboratories ..... Chicago, Ill.
Allen & Co., L. B. ..... Chicago, Ill.
Allen & Co., S. L. Co. ..... Philadelphia, Pa.
Adt Co., John B. ..... Baltimore, Md.
American Frog & Switch Co. ..... Hamilton, Ohio.
American Malleables Co. ..... Lancaster, N. Y.
Addressograph Co. ..... Chicago, Ill.
Acheson Graphite Co. ..... Niagara Falls, N. Y.
Avery Co. ..... Peoria, Ill.
Allis-Chalmers Mfg. Co. ..... Milwaukee, Wis.

Atkins & Co., E. C. ..... Indianapolis, Ind.
American Seating Co. ..... New York, N. Y.
Ainsworth & Sons, Wm. ..... Denver, Col.
American Machine & Mfg. Co. ..... Greenville, S. C.
American Chain Co., Inc. ..... New York, N. Y.
Ajax Metal Co. ..... Philadelphia, Pa.
Allegheny Steel Co. ..... Pittsburgh, Pa.
American Seeding Machine Co. ..... Springfield, Ohio.
Albough-Dover Co. ..... Chicago, Ill.

Barcalo Mfg. Co. ..... Buffalo, N. Y.
Betz Co., Frank S. ..... Hammond, Ind.
Blish Milling Co. ..... Seymour, Ind.
Ballwood Co. ..... New York, N. Y.
Bridgeport Brass Co. ..... Bridgeport, Conn.
Berry Bros. ..... Detroit, Mich.
Burke & James ..... Chicago, Ill.
Blount Co., J. G. ..... Everett, Mass.
Bryant Electric Co. ..... Bridgeport, Conn.
Bahmann Iron Works Co. ..... Cincinnati, Ohio.
Baltimore Enamel & Novelty Co. ..... Baltimore, Md.
Benedict Mfg. Co. ..... East Syracuse, N. Y.
Baker-Vawter Co. ..... Benton Harbor, Mich.
Brown & Sharpe Mfg. Co. ..... Providence, R. I.
Bausch & Lomb Optical Co. ..... Rochester, N. Y.
Burt & Packard Co. ..... Brockton, Mass.
Byram Veneer & Lbr. Co. ..... Byram, Miss.
Babcock & Wilcox Co. ..... New York, N. Y.
Bound Brook Oil-less Bearing Co. ..... Bound Brook, N. J.
Bower Chemical Mfg. Co., Henry ..... Philadelphia, Pa.
Bagdad Land & Lumber Co. ..... Bagdad, Florida.
Buffalo Foundry & Machine Co. ..... Buffalo, N. Y.
Blair Mfg. Co. ..... Springfield, Mass.
Barnes Mfg. Co. ..... Mansfield, Ohio.
Block Gas Mantle Co. ..... Youngstown, Ohio.
Butler & Hazeltine ..... Haverhill, Mass.
Boston Woven Hose & Rubber Co. ..... Cambridge, Mass.
Belden Manufacturing Co. ..... Chicago, Ill.
Brunner Mfg. Co. ..... Utica, N. Y.
Bendixen, P. ..... Bettendorf, Ia.
Benjamin Electric Mfg. Co. ..... Chicago, Ill.
Bristol Patent Leather Co. ..... Boston, Mass.
Burt Machine Co. ..... Baltimore, Md.
Builders Iron Foundry ..... Providence, R. I.
Bishop & Co. Platinum Works, J. ..... Malvern, Pa.
Bullock Mfg. Ass'n. ..... Springfield, Mass.
Blaisdell Pencil Co. ..... Philadelphia, Pa.
Blood & Co., Inc., John ..... Philadelphia, Pa.
Blanchard Machine Co. ..... Cambridge, Mass.
Belmont Iron Works ..... Philadelphia, Pa.
Burroughs Adding Machine Co. ..... Detroit, Mich.
Baker Brothers ..... Toledo, Ohio.
Baltimore Copper Plate Co. ..... Baltimore, Md.

Banister Co., J. A. ..... Newark, N. J.
Benton Machine Tool Co. ..... Bridgeport, Conn.
Barrett Company ..... New York, N. Y.
Brode & Co., F. W. ..... Memphis, Tenn.
Besley & Co., C. H. ..... Chicago, Ill.
Barney & Berry, Inc. ..... Springfield, Mass.
Bessemer Gas Engine Co. ..... Grove City, Pa.
Berger Mfg. Co. ..... New York, N. Y.
Bearings Co. of America ..... Lancaster, Pa.
Bacurle & Morris ..... Philadelphia, Pa.
Bowen Mfg. Co. ..... Auburn, N. Y.
Brennan Packing Co. ..... Chicago, Ill.
Berger Mfg. Co. ..... Canton, Ohio.
Bramhall, Deane Co. ..... New York, N. Y.
Bryant Paper Co. ..... Kalamazoo, Mich.
Burgess Sulphite Fibre Co. ..... Portland, Maine.
Bliss Fabyan & Co. ..... New York, N. Y.
Burt Mfg. Co. ..... Akron, Ohio.
Ballantine & Sons, P. ..... Newark, N. J.
Buffalo Wire Works Co. ..... Buffalo, N. Y.
Brennan & Co., John ..... Detroit, Mich.
Butler Edwards Electric Co. ..... Easton, Pa.
Bradley & Vrooman Co. ..... Chicago, Ill.
Brown Instrument Co. ..... Philadelphia, Pa.
Buffalo Dental Mfg. Co. ..... Buffalo, N. Y.
Baum's Castorine Co. ..... Rome, N. Y.
Boomer & Boschert Press Co. ..... Syracuse, N. Y.
B. & K. Mfg. Co. ..... New Britain, Conn.
Beaman Smith Co. ..... Providence, R. I.
Boston Machine Works Co. ..... Lynn, Mass.
The Baker Mfg. Co. ..... Springfield, Ill.
Bryden Horse Shoe ..... Catasauqua, Pa.
Bignall & Keeler Machine Works ..... Edwardsville, Ill.
Boyd & Bro., James ..... Philadelphia, Pa.
Bean Spray Pump Co. ..... San Jose, Cal.
Byers Co., A. M. ..... Pittsburgh, Pa.
Blaw-Knox Co. ..... Pittsburgh, Pa.
Black & Decker Mfg. Co. ..... Baltimore, Md.
Baldwin Locomotive Works ..... Philadelphia, Pa.
Bristol Co. ..... Waterbury, Conn.
Beacon Falls Rubber Shoe Co. ..... Beacon Falls, Conn.
Buckeye Traction Ditcher Co. ..... Findley, Ohio.
Buffalo Steam Pump Co. ..... North Tonawanda, N. Y.
Borden Co. ..... Warren, Ohio.
Buffalo Scale Co. ..... Buffalo, N. Y.
Bunting Brass & Bronze Co. ..... Toledo, Ohio.
Barnes Drill Co. ..... Rockford, Ill.
Brown Portable Conveying Machinery Co. ..... Chicago, Ill.
Borne, Scrymser Co. ..... New York, N. Y.
Buffalo Meter Co. ..... Buffalo, N. Y.
Bliss Co., E. W. ..... Brooklyn, N. Y.
Birmingham Iron Foundry ..... Derby, Vt.
Ball Engine Co. ..... Erie, Pa.

Boston Pressed Metal Co. ..... Worcester, Mass.
Black-Clawson Co. ..... Hamilton, Ohio.
Berkeley Electric Cooker Co. ..... San Francisco, Cal.
Briscoe Motor Corporation ..... Jackson, Mich.
Buffalo Bolt Co. ..... Tonawanda, N. Y.
Burson Knitting Co. ..... Rockford, Ill.
Brookside Mills ..... Knoxville, Tenn.
Burr Mfg. Co. ..... Cleveland, Ohio.
Billings & Spencer Co. ..... Hartford, Conn.
Bentel & Margedant Co. ..... Hamilton, Ohio.
Baeder, Adamson & Co. ..... Philadelphia, Pa.
Boston Bottle Wiring & Labeling Co. ..... Boston, Mass.
Beechnut Packing Co. ..... Canajoharie, N. Y.
Baker R. & L. Co. ..... Cleveland, Ohio.
Bagley & Sewall Co. ..... Watertown, N. Y.
Baird Machine Co. ..... Bridgeport, Conn.
Babcock Printing Press Mfg. Co. ..... New London, Conn.
Bowman, C. C. ..... Pittston, Pa.
Brown Folding Machine Co. ..... Erie, Pa.
Bradley & Son, Inc., C. C. ..... Syracuse, N. Y.
Bucyrus Co. ..... South Milwaukee, Wis.
Brecht Company ..... St. Louis, Mo.
Belmont Packing Rubber Co. ..... Philadelphia, Pa.
Bertman Electric Co ..... Chicago, Ill.
Baltimore Pearl Hominy Co. ..... Baltimore, Md.
Bessemer Motor Truck Co. ..... Grove City, Pa.

Cumberland Steel Co. ..... Cumberland, Md.
Clark Equipment Co. ..... Buchanan, Mich.
Chicago Rawhide Mfg. Co. ..... Chicago, Ill.
Champion Ignition Co. ..... Flint, Mich.
Cabot, Samuel, Incorporated ..... Boston, Mass.
Columbian Bronze Corp. ..... Freeport, L. I.
Cincinnati Planer Co. ..... Cincinnati, Ohio.
Card Mfg. Co., S. W. ..... Mansfield, Mass.
Chain Belt Co. ..... Milwaukee, Wis.
Cluett, Peabody & Co., Inc. ..... Troy, N. Y.
Corona Typewriter Co., Inc. ..... Groton, N. Y.
Cudahy Packing Co. ..... Chicago, Ill.
Cincinnati Bickford Tool Co. ..... Cincinnati, Ohio.
Clyde Iron Works ..... Duluth, Minn.
Coplay Cement Mfg. Co. ..... New York, N. Y.
Corning Glass Works ..... Corning, N. Y.
Chemical Company of America ..... New York, N. Y.
Cleveland Twist Drill Co. ..... Cleveland, Ohio.
California & Hawaiian Sugar Refining Co. ..... Crockett, Calif.
Columbus Aseptic Furniture Co. ..... Columbus, Ohio.
Computing Scale Co. ..... Dayton, Ohio.
Commercial Boiler Works ..... Seattle, Wash.
Castle Engineering Co., A. M. ..... LaCrosse, Wis.
Cochran Pipe Wrench Mfg. Co. ..... Chicago, Ill.
Canfield Oil Co. ..... Cleveland, Ohio.
Clarb, Jr., James, Electric Co. ..... Louisville, Ky.

Clark & Co., George M., Div. American Stove Co. ..... Chicago, Ill.
Chicago Veneer Company ..... Chicago, Ill.
Crane Company ..... Chicago, Ill.
Cadman Manufacturing Co., A. W. ..... Pittsburgh, Pa.
California Corrugated Culvert Co. ..... West Berkeley, Cal.
Church Co., John ..... Cincinnati, Ohio.
Chandler & Taylor Co. ..... Indianapolis, Ind.
Coatsville Boiler Works ..... Coatesville, Pa.
Columbian Iron Works ..... Chattanooga, Tenn.
Cutler-Hammer Mfg. Co. ..... Milwaukee, Wis.
Cunningham Son & Co., Jas. ..... Rochester, N. Y.
Challenge Company ..... Batavia, Ill.
Colwell, Lewis ..... Chicago, Ill.
Carnation Milk Products Co. ..... Seattle, Wash.
Chicago Belting Co. ..... Chicago, Ill.
Cowles & Co., C. ..... New Haven, Conn.
Cole Motor Car Co. ..... Indianapolis, Ind.
Crocker Wheeler Co. ..... Ampere, N. J.
Cling Surface Company ..... Buffalo, N. Y.
Commonwealth Shoe & Lea. Co. ..... Boston, Mass.
Covert's Saddlery Works ..... Interlaken, N. Y.
Cleveland Metal Products Co. ..... Cleveland, Ohio.
Chicago Tape & Label Co. ..... Chicago, Ill.
Carr Fastener Company ..... Cambridge, Mass.
Corbin Screw Corporation ..... New Britain, Conn.
Columbia Graphophone Company ..... Woolworth Bldg., N. Y.
Columbia Wagon Co. ..... Columbia, Pa.
Commonwealth Motors Co. ..... Chicago, Ill.
Cleveland-Cliffs Iron Co. ..... Cleveland, Ohio.
Certain-teed Products Corp. ..... New York, N. Y.
Chambers Bros. Co. ..... Philadelphia, Pa.
Carton Belting Co. ..... Boston, Mass.
Chase Turbin Mfg. Co. ..... Orange, Mass.
C. & C. Electric Mfg. Co. ..... Garwood, N. J.
Couple Gear & Freight Wheel Co. ..... Grand Rapids, Mich.
Cleveland Tanning Co. ..... Cleveland, Ohio.
Central Scientific Co. ..... Chicago, Ill.
California Paint Co. ..... Oakland, Calif.
Chattanooga Implement & Mfg. Co. ..... Chattanooga, Tenn.
Capron Co. ..... Providence, R. I.
California Ripe Olive Co. ..... Oroville, Cal.
Camden Anchor-Rockland Machine Co. ..... Camden, Maine.
Continental Salt & Chemical Co. ..... San Francisco, Cal.
Cornell Wood Products Co. ..... Chicago, Ill.
Cleveland Automatic Machine Co. ..... Cleveland, Ohio.
Carter's Ink Company ..... Boston, Mass.
Cobb, S. H. ..... Lynn, Mass.
Case Threshing Machine Co., J. I. ..... Racine, Wis.
Colton Company, Arthur ..... Detroit, Mich.
Corbin & Son Co., B. A. ..... Webster, Mass.
Chicago Wheel & Mfg. Co. ..... Chicago, Ill.
Chicago Spring Butt Company ..... Chicago, Ill.
Caloric Co. ..... Janesville, Wis.

Columbus Bolt Works Co. ... Columbus, Ohio.
Cleveland Steel Tool Co. ... Cleveland, Ohio.
Curtis Pneumatic Mchy. Co. ... St. Louis, Mo.
Continental Refining Co. ... Oil City, Pa.
Chatillon & Son, John ... New York, N. Y.
Carnes Artificial Limb Co. ... Kansas City, Mo.
Calumet & Hecla Mining Co. ... Boston, Mass.
Castner, Curran & Bullitt, Inc. ... New York, N. Y.
Cheney Bigelow Wire Works ... Springfield, Mass.
Crown Cork & Seal Co. ... Baltimore, Md.
Columbia Rope Co. ... Auburn, N. Y.
Caille Perfection Motor Co. ... Detroit, Mich.
Consumers Biscuit Co. ... New Orleans, La.
Cincinnati Gear Cutting Machine Co. ... Cincinnati, Ohio.
Cincinnati Shaper Co. ... Cincinnati, Ohio.
Chadwick-Boston Lead Co. ... Boston, Mass.
Cresson Morris Co. ... Philadelphia, Pa.
Cooks Linoleum Co. ... Trenton, N. J.
Clark Bros. Co. ... Olean, N. Y.
Collins Company ... Collinsville, Conn.
Clark & Coombs Co. ... Providence, R. I.
Cheney Brothers ... South Manchester, Conn.
Cohen Trolley Track Mfg. Co. ... Holyoke, Mass.
Converse Rubber Shoe Co. ... Malden, Mass.
Corey Leather Co. ... Boston, Mass.
Century Electric Co. ... St. Louis, Mo.
Curtis & Marble Machine Co. ... Worcester, Mass.
Carrier Engineering Corporation ... New York, N. Y.
Chicago Screw Co. ... Chicago, Ill.
Cushman Motor Works ... Lincoln, Neb.
Cincinnati Milling Machine Co. ... Cincinnati, Ohio.
Clayton & Lambert Mfg. Co. ... Detroit, Mich.
California Barrel Co. ... San Francisco, Cal.
Cadillac Motor Car Co. ... Detroit, Mich.
Chicago Pump Co. ... Chicago, Ill.
Commerce Motor Car Co. ... Detroit, Mich.
Columbus Union Oil Cloth Co. ... Columbus, Ohio.
Conneaut Leather Co. ... Conneaut, Ohio.
Crane & Breed Mfg. Co. ... Cincinnati, Ohio.
Corega Chemical Co. ... Cleveland, Ohio.
Chicago Retort & Fire Brick Co. ... Chicago, Ill.
George Cutler Co. ... South Bend, Ind.
Columbian Steel Tank Co. ... Kansas City, Mo.
Cushman Chuck Co. ... Hartford, Conn.
Climax Fire Brick Co. ... Climax, Pa.
Cufeld Waste & Batting Co. ... Saylesville, R. I.
Carver Cotton Gin Co. ... E. Bridgewater, Mass.
Campbell Company, Joseph ... Camden, N. J.
Cattaraugus Tanning Co. ... Boston, Mass.
Crouse Hinds Co. ... Syracuse, N. Y.
Central Foundry Co. ... New York, N. Y.
Chandler & Price Co. ... Cleveland, Ohio.
Climax Co., J. H. W. ... Newark, N. J.

Crescent Machine Co. ..... Leetonia, Ohio.
Commercial Lubricating Co. ..... Philadelphia, Pa.
Coldwell Lawn Mower ..... Newburgh, N. Y.
Copeland Co., Martin ..... Providence, R. I.
Champion Horse Shoe Co. ..... Pawtucket, R. I.
Caldwell & Son Co., H. W. ..... Chicago, Ill.
Coes Wrench Co. ..... Worcester, Mass.
Corn Products Refining Co. ..... New York, N. Y.
Commercial Car Unit Company ..... Philadelphia, Pa.
Clark Wire Co., W. A. ..... Elizabeth, N. J.

du Pont de Nemours & Co., E. I. ..... Wilmington, Delaware.
Detroit Copper & Brass Rolling Mills ..... Detroit, Mich.
DeVilbiss Mfg. Co. ..... Toledo, Ohio.
Davol Rubber Company ..... Providence, R. I.
Diamond State Fibre Co. ..... Bridgeport, Pa.
Decker Mfg. Co. ..... Keokuk, Iowa.
Davenport Locomotive Works ..... Davenport, Iowa.
Domestic Engineering Co. ..... Dayton, Ohio.
Dodge Manufacturing Co. ..... Mishawaka, Ind.
Diamond Drill Co. ..... Sherman, Texas.
Dutcher & Co., Frank Wm. ..... Boston, Mass.
Dexter Portland Cement Co. ..... Nazareth, Pa.
Dort Motor Car Co. ..... Flint, Mich.
Detroit Twist Drill Co. ..... Detroit, Mich.
Detrick & Harvey Machine Co. ..... Baltimore, Md.
Dallas Waste Mills ..... Dallas, Texas.
Dyer Company ..... Cleveland, Ohio.
Douglas Shoe Co., W. L. ..... Brockton, Mass.
Diehl Mfg. Co. ..... Elizabeth, N. J.
Darnell, Inc., R. J. ..... Memphis, Tenn.
Diamond Chain & Mfg. Co. ..... Indianapolis, Ind.
Durham Duplex Razor Co. ..... Jersey City, N. J.
Dick, Co., A. B. ..... Chicago, Ill.
Dayton Mfg. Co. ..... Dayton, Ohio.
Davis Machine Tool Co., Inc. ..... Rochester, N. Y.
Davis Mfg. Co. ..... Milwaukee, Wis.
Durant Mfg. Co. ..... Milwaukee, Wis.
Desmond Stephan Mfg. Co. ..... Urbana, Ohio.
Duntley Products Co. ..... Erie, Pa.
Durand Steel Locker Co. ..... Chicago Heights, Ill.
Detroit Shipbuilding Co. ..... Detroit, Mich.
Dennison Manufacturing Co. ..... Framingham, Mass.
Dauch Mfg. Co. ..... Sandusky, Ohio.
Detroit Steel Products Co. ..... Detroit, Mich.
Denby Motor Truck Co. ..... Detroit, Mich.
Denver Rock Drill Mfg. Co. ..... Denver, Colo.
Dodge Brothers ..... Detroit, Mich.
Douglas Company ..... Cedar Rapids, Iowa.
Dexter Sulphite Pulp & Paper Co. ..... Dexter, N. Y.
Dines Jr. Co., William L. ..... Worcester, Mass.
Dalton Adding Machine Co. ..... Norwood, Ohio.
Dain Manufacturing Co. ..... Ottumwa, Iowa.

Dart Motor Truck Co. ..... Waterloo, Iowa.
Delta File Works ..... Philadelphia, Pa.
Dougherty & Co., Inc., H. D. ..... Philadelphia, Pa.
Diamond Machine Co. ..... Providence, R. I
Davis Birely Table Co. ..... Shelbyville, Ind.
Dill Machine Co., T. C. ..... Philadelphia, Pa.
Daisy Mfg. Co. ..... Plymouth, Mich.
Detroit Oak Belting Co. ..... Detroit. Mich.
Dodge Steel Pulley Corp. ..... Oneida, N. Y.
Duff Mfg. Co. ..... Pittsburgh, Pa.
Dunlop Mills ..... Richmond, Va.
Disston & Sons, Inc., Henry ..... Philadelphia, Pa.
Draeger Oxygen Apparatus Co. ..... Pittsburgh, Pa.
Deming Co. ..... Salem, Ohio.
Devine Co., J. P. ..... Buffalo, N. Y.

Eastman Kodak Co. ..... Rochester, N. Y.
Ensign-Bockford Co. ..... Simsbury, Conn.
Electric Hose & Rubber Co. ..... Wilmington, Del.
Empire Manufacturing Co. ..... Lockport, N. Y.
Edwards Co., Inc., O. M. ..... Syracuse, N. Y.
Electric Machinery Co. ..... Minneapolis, Minn.
Essanay Film Mfg. Co. ..... Chicago, Ill.
Eastern Malleable Iron Co., Inc. ..... Troy, N. Y.
Eureka Company ..... North East, Pa.
Erie City Iron Works ..... Erie, Pa.
Emery Candle Co. ..... Cincinnati, Ohio.
Essenay Products Co. ..... Chicago, Ill.
Eastern Manufacturing Co. ..... Bangor, Maine.
Erie Foundry Co. ..... Erie, Pa.
Excelsior Steel Ball Co. ..... Buffalo, N. Y.
Eberhard Manufacturing Co. ..... Cleveland, Ohio.
Emerson Pump & Valve Co., Inc. ..... Alexandria, Va.
Elyria Enameled Products Co. ..... Elyria, Ohio.
Eastern Bridge & Structural Co. ..... Worcester, Mass.
Economy Lubricating Co. ..... Boston, Mass.
Electric Controller & Mfg. Co. ..... Cleveland, Ohio.
Ericsson Manufacturing Co. ..... Buffalo, N. Y.
Edison Storage Battery Co. ..... Orange, N. J.
Enameled Metals Co. ..... Etna, Pa.
Edwards Lumber Co., E. I. ..... Dayton, Ohio.
Eastwood Co., Benjamin ..... Paterson, N. J.
Electro Dental Mfg. Co. ..... Philadelphia, Pa.
Enterprise Mfg. Co. ..... Philadelphia, Pa.
Eastman Machine Co. ..... Buffalo, N. Y.
Epping Carpenter Pump Co. ..... Pittsburgh, Pa.
Eichleay, Jr. Co., John ..... Pittsburgh, Pa.
Eagle Suspender & Belt Co., Inc. ..... Philadelphia, Pa.
Evans Stamping & Plating Co. ..... Taunton, Mass.
Electric Heating Apparatus Co. ..... Newark, N. J.
Elgin National Watch Co. ..... Elgin, Ill.
Eagle Pipe Supply Co., Inc. ..... New York, N. Y.
Edison Portland Cement Co. ..... Stewartsville, N. J.

Eagle Iron Works.....Des Moines, Iowa.
Emerson Electric Mfg. Co.....St. Louis, Mo.
Elliott Machine Co.....Grand Rapids, Mich.
Eureka Machine Co.....Lansing, Mich.
Economy Fuse & Mfg. Co.....Chicago, Ill.
Elwell-Parker Electric Co.....Cleveland, Ohio.
Economy Drawing Table Co.....Toledo, Ohio.
Eisendrath Tanning Co.....Racine, Wis.
Electric Wheel Co.....Quincy, Ill.
Empire Automobile Co.....Indianapolis, Ind.
Essex Rubber Co.....Trenton, N. J.
Eastman, Gardiner & Co.....Laurel, Miss.
Espen Lucas Machine Works.....Philadelphia, Pa.
Eclipse Cement & Blacking Co.....Philadelphia, Pa.
Edmund & Jones Corp.....Detroit, Mich.
Empire Manufacturing Co.....Quincy, Ill.
Elm City Cotton Mills.....La Grange, Ga.
Elliott-Fisher Co.....Harrisburg, Pa.

Fox Typewriter Co.....Grand Rapids, Mich.
Ferracute Machine Co.....Bridgeton, N. J.
Fox Machine Co.....Jackson, Mich.
Fuller & Warren Co.....New York, N. Y.
Finola Manufacturing Co.....Hannibal, Mo.
Fate Co., J. D.....Plymouth, Ohio.
Fairmont Gas Engine & Ry. Motor Car Co.....Fairmont, Minn.
Fostoria Glass Co.....Moundsville, W. Va.
Fulton Iron Works Co.....St. Louis, Mo.
Field & Co., Marshall.....Chicago, Ill.
Fischer & Pruefer.....Providence, R. I.
Fawcus Machine Co.....Pittsburgh, Pa.
Florence Mining & Milling Co.....Philadelphia, Pa.
Freeman Electric Co., E. H.....Trenton, N. J.
Fulton Bag & Cotton Mills.....Atlanta, Ga.
Frost-Superior Fence Co.....Cleveland, Ohio.
Fort Stanwix Canning Co.....Rome, N. Y.
Fox Specialty Co., A. P.....Indianapolis, Ind.
Frost Company, George.....Boston, Mass.
Folwell Bros. & Co.....Collingwood Mills.
Fibre Conduit Co.....Orangeburg, N. Y.
Flood & Conklin Co.....Newark, N. J.
Fonda Glove Lining Co.....Fonda, N. Y.
Firth Sterling Steel Co.....McKeesport, Pa.
Flannery Bolt Co.....Pittsburgh, Pa.
Felt & Tarrant Mfg. Co.....Chicago, Ill.
Firestone Tire & Rubber Co.....Akron, Ohio.
Fellows Gear Shaper Co.....Springfield, Vt.
Foster Bros. Mfg. Co.....Utica, N. Y.
Filer & Stowell Co.....Milwaukee, Wis.
Fuchs & Lang Mfg. Co.....New York, N. Y.
Federal Motor Truck Co.....Detroit, Mich.
Fels & Co.....Philadelphia, Pa.
Frantz Premier Company.....Cleveland, Ohio.

Franklin Mfg. Co. ..... Franklin, Pa.
Franco-American Food Co. ..... Jersey City, N. J.
Fairbanks, Morse & Co. ..... Chicago, Ill.
Fay & Scott ..... Dexter, Maine.
Faultless Rubber Co. ..... Ashland, Ohio.
Furst Bros. & Co. ..... Baltimore, Md.
Ford Motor Co. ..... New York, N. Y.
Fox Gun Co., A. H. ..... Philadelphia, Pa.
Foos Gas Engine Co. ..... Springfield, Ohio.
Fisher Governor Co. ..... Marshalltown, Iowa.
Frick Company ..... Waynesboro, Pa.
Fisk Rubber Co. ..... Chicopee Falls, Mass.
Foote Mineral Co. ..... Philadelphia, Pa.

Greenfield Tap & Die Corp. ..... Greenfield, Mass.
Gulf Cooperage Co. ..... Texarkana, Texas.
Gossard Co., Inc., H. W. ..... Chicago, Ill.
Graton & Knight Mfg. Co. ..... Worcester, Mass.
Grange Co., J. P. ..... Providence, R. I.
Gilman & Son ..... Springfield, Vt.
Grasselli Chemical Co. ..... New York, N. Y.
Gisholt Machine Co. ..... Madison, Wis.
Grand Rapids Show Case Co. ..... Grand Rapids, Mich.
Great Western Mfg. Co. ..... Laporte, Ind.
Growers Rice Mfg. Co. ..... San Francisco, Cal.
Geneva Wagon Co. ..... Geneva, N. Y.
Gifford Co., Bishop ..... Baldwin, N. Y.
Grant Powder Co. ..... Grant, Cal.
Gordon Co., J. P. ..... Columbus, Ohio.
Glauber Brass Mfg. Co. ..... Cleveland, Ohio.
Goodrich & Co., Hazen B. ..... Haverhill, Mass.
Gray Motor Co. ..... Detroit, Mich.
Gilbert & Bark Mfg. Co. ..... Springfield, Mass.
Geometric Tool Co. ..... New Haven, Conn.
Gleason Works ..... Rochester, N. Y.
Great Southern Lumber Co. ..... Bogalusa, La.
Goulds Mfg. Co. ..... Seneca Falls, N. Y.
Grand Rapids Brass Co. ..... Grand Rapids, Mich.
Grand Rapids Veneer Works ..... Grand Rapids, Mich.
Gill Brothers Co. ..... Steubenville, Ohio.
Graham, Gervaise ..... Chicago, Ill.
Gray Co., G. A. ..... Cincinnati, Ohio.
General Elevator Co. ..... New York, N. Y.
General Fireproofing Company ..... New York, N. Y.
Griffin Wheel Co. ..... Chicago, Ill.
Goodrich Rubber Co., B. F. ..... Akron, Ohio.
Goodell-Pratt Co. ..... Greenfield, Mass.
Gloversville Knitting Co. ..... Gloversville, N. Y.
Greenfield Machine Co. ..... Greenfield, Mass.
Griffin Mfg. Co. ..... Erie, Pa.
Graham Mfg. Co. ..... Providence, R. I.
Granger & Co., Jno. A. ..... Chicago, Ill.
General American Tank Car Corp. ..... Chicago, Ill.

Glens Falls Machine Works.....Glens Falls, N. Y.
Great Western Smelting & Refining Co.....Chicago, Ill.
Glasgow Iron Co.....Pottstown, Pa.
Graham Paper Co.....St. Louis, Mo.
Gutmann & Co.....Chicago, Ill.
Gardner Governor Co.....Quincy, Ill.
Garford Motor Truck Co.....Lima, Ohio.
Gemco Manufacturing Co.....Milwaukee, Wis.
Gambrill Mfg. Co., C. A.....Baltimore, Md.
G. & J. Tire Co.....Indianapolis, Ind.
Gifford Wood Co.....Hudson, N. Y.
Glidden Varnish Co.....New York, N. Y.
Goetze Gasket & Packing Co.....New Brunswick, N. J.
Green Fuel Economizer Co.....Beacon, N. Y.
Georgia Mfg. Co.....Columbus, Ga.
Gupull, H. E.....Haverhill, Mass.
Gregg Company, Ltd.....Hackensack, N. J.
Goodyear Tire & Rubber Co.....Akron, Ohio.

Hoover Steel Ball Co.....Ann Arbor, Mich.
Hindley Gear Co.....Philadelphia, Pa.
Horlick's Malted Milk Co.....Racine, Wis.
Howard Dustless Duster Co.....Boston, Mass.
Hazen Brown Company.....Brockton, Mass.
Heinemann Electric Co.....Philadelphia, Pa.
Houston, Stanwood & Gamble Co.....Cincinnati, Ohio.
Hunter Saw & Machine Co.....Pittsburgh, Pa.
Hardinge Brothers, Inc.....Chicago, Ill.
Hamilton Machine Tool Co.....Hamilton, Ohio.
Hazard Mfg. Co.....Wilkes Barre, Pa.
Hussey & Co., C. G.....Pittsburgh, Pa.
Hamilton Mfg. Co.....Two Rivers, Wis.
Hudson Mfg. Co.....Hastings, Minn.
Hately Bros.....Chicago, Ill.
Hayes Pump & Planter Co.....Galva, Ill.
Hammond Standish & Co.....Detroit, Mich.
Hampshire Paper Co.....South Hadley Falls, Mass.
Hardwood Products Co.....Neenah, Wis.
Hawaiian Pineapple Co., Ltd.....San Francisco, Cal.
Hurley Machine Co.....Chicago, Ill.
Hettler Lumber Co., Herman H.....Chicago, Ill.
Holeproof Hosiery Co.....Milwaukee, Wis.
Hess Warming & Ventilating Co.....Chicago, Ill.
Hudson Motor Car Company.....Detroit, Mich.
Hale-Boardman, Inc., John M.....New York, N. Y.
Holt Manufacturing Co.....Peoria, Ill.
Henry & Wright Mfg. Co.....Hartford, Conn.
Herschel-Spillman Co.....Tonawanda, N. Y.
Henry & Co., A. H.....Newark, Ohio.
Hotaling Warner Co.....Syracuse, N. Y.
Homestead Valve Mfg. Co.....Homestead, Pa.
Heinoff Machine Co.....Astoria, L. I., N. Y.
Humphrey Company.....Kalamazoo, Mich.

Harry Bros. Co. ..... New Orleans, La.
Hardsoeg Wonder Drill Co. ..... Ottumwa, Iowa.
Holmes Machinery Co., E. & B. ..... Buffalo, N. Y.
Hail & Cotton ..... Louisville, Ky.
Hightower Box & Tank Co. ..... Atlanta, Ga.
Harmony Company ..... Chicago, Ill.
Hobson & Company ..... Easton, Pa.
Holyoke Card & Paper Company ..... Springfield, Mass.
Herzog, Albert ..... New York, N. Y.
Holmes & Blanchard Co. ..... Boston, Mass.
Hoopes, Bro. & Darlington, Inc. ..... West Chester, Pa.
Hazzard Co., R. P. ..... Gardiner, Maine.
Hendey Machine Co. ..... Torrington, Conn.
H. & B. American Machine Co. ..... Pawtucket, R. I.
Harrison Safety Boiler Works ..... Philadelphia, Pa.
Heebner & Sons ..... Lansdale, Pa.
Harrington Cutlery Co. ..... Southbridge, Mass.
Hasselbarth, C. O. ..... Albany, N. Y.
Hamilton Mfg. Co. ..... Lowell, Mass.
Heublein & Bro., G. F. ..... Hartford, Conn.
Heller & Brightly ..... Philadelphia, Pa.
Hampden Corundum Wheel Co. ..... Brightwood, Mass.
Hart & Hutchinson Company ..... New Britain, Conn.
Harrington & Richardson Arms Co. ..... Worcester, Mass.
Holt & Sons, Lawrence S. ..... Burlington, N. C.
Herman & Herman, Inc. ..... New York, N. Y.
Hazel-Atlas Glass Co. ..... Wheeling, W. Va.
Heide, Henry ..... New York, N. Y.
Hodges Fiber Carpet Co. ..... New York, N. Y.
Hunt Co., Inc., C. W. ..... New York, N. Y.
Haskell & Barker Car Co., Inc. ..... Chicago, Ill.
Hutchinson Coal Co. ..... Philadelphia, Pa.
Hankey & Co., Inc., A. ..... Rochdale, Mass.
Hisey-Wolf Machine Co. ..... Cincinnati, Ohio.
Hendrick Mfg. Co. ..... Carbondale, Pa.
Hood Co., John ..... Boston, Mass.
Hobart Mfg. Co. ..... Troy, Ohio.
H. & O. Arms Co. ..... Norwich, Conn.
Hess Machine Works ..... Philadelphia, Pa.
Hoosier Mfg. Co. ..... New Castle, Ind.
Harrington & King Perforating Co. ..... Chicago, Ill.
Heyden Chemical Works ..... New York, N. Y.
Herschel Mfg. Co., R. ..... Peoria, Ill.
Hart & Hegeman Mfg. Co. ..... Hartford, Conn.
Howes Co., S. ..... Silver Creek, N. Y.
International Harvester Corp. ..... Chicago, Ill.
International Shoe Co. ..... St. Louis, Mo.
Ideal Concrete Machinery Co. ..... Cincinnati, Ohio.
Independent Refining Co., Ltd. ..... Oil City, Pa.
Ellwood Ivins' Tube Works ..... Philadelphia, Pa.
Ives Co., H. ..... New Haven, Conn.
Industrial Works ..... Bay City, Mich.
International Leather Co. ..... Boston, Mass.

Irwin Auger Bit Co. ..... Wilmington, Ohio.
International Fruit Products Co. ..... Cincinnati, Ohio.
Illinois Razor Strop Co. ..... Chicago, Ill.
International Equipment Co. ..... Boston, Mass.
International Motor Co. ..... New York, N. Y.
International Casement Co. ..... Jamestown, N. Y.
Iron City Tool Works, Ltd. ..... Pittsburgh, Pa.
International Filter Co. ..... Chicago, Ill.
Ideal Electric & Mfg. Co. ..... Mansfield, Ohio.
Illinois Glass Co. ..... Alton, Ill.
International Register Co. ..... Chicago, Ill.
Indiana Refining Co. ..... New York, N. Y.
Ingersoll & Bro., Robt. H. ..... New York, N. Y.
Ingersoll Milling Machine Co. ..... Rockford, Ill.
Inland Machine Works ..... St. Louis, Mo.
Independent Pneumatic Tool Co. ..... Aurora, Ill.
International Time Recording Co. ..... Endicott, N. Y.
Ide & Co., George P. ..... Troy, N. Y.
Iglehart Brothers ..... Evansville, Ind.
Indiana Moulding & Frame Co. ..... Laporte, Ind.
Illinois Watch Case Co. ..... Elgin, Ill.

Johnson Soap Co., Inc., S. J. ..... Milwaukee, Wis.
Joubert & Goslin Machine & Foundry Co. ..... Birmingham, Ala.
Jones & Lamson Machine Co. ..... Springfield, Vt.
Jones Hollow Ware Co. ..... Baltimore, Md.
Johns-Manville Co., H. W. ..... New York, N. Y.
Jeffrey Manufacturing Co. ..... Columbus, Ohio.
Jones & Laughlin Steel Co. ..... Pittsburgh, Pa.
Jenckes Knitting Machine Co. ..... Pawtucket, R. I.
Joliet Mfg. Co. ..... Joliet, Ill.
Johnston Optical Co. ..... Detroit, Mich.
Jefferson Glass Co. ..... Follansbee, W. Va.
Jackson Automobile Co. ..... Jackson, Mich.
Jackson Mills Emery Co., Inc. ..... Easton, Pa.
Jamison Cold Storage Door Co. ..... Hagerstown, Md.
Johnston Harvester Co. ..... Batavia, N. Y.
James Mfg. Co. ..... Fort Atkinson, Wis.
Judson Mfg. Co. ..... San Francisco, Cal.

Keith Shoe Co., Preston B. ..... Campello, Mass.
Kearney & Tuck Co. ..... Milwaukee, Wis.
Knox Gelatine Co., Inc., Charles B. ..... Johnstown, N. Y.
Knowlton Bros. ..... Watertown, N. Y.
Knowles, Taylor & Knowles Co. ..... East Liverpool, Ohio.
Keith Car & Mfg. Co. ..... Sagamore, Mass.
Knickerbocker Case Co. ..... Chicago, Ill.
Kochs Co., Theo. A. ..... Chicago, Ill.
Keever Starch Co. ..... Columbus, Ohio.
Kramer Rotary Harrow Co. ..... Morton, Ill.
Krause & Managan Lumber Co., Ltd. ..... Westlake, La.
Kelly & McLaughlin, Inc. ..... Newark, N. J.

Kin———Mfg. Co. ..... Columbus, Ohio.
Kokomo Electric Co. ..... Kokomo, Ind.
Ky Wagon Mfg. Co. ..... Louisville, Ky.
Kidder Press Co. ..... Dover, N. H.
Kerr Turbine Co. ..... Wellsville, N. Y.
Knoll Manufacturing Co. ..... Reading, Pa.
Kuty Co., G. J. ..... Wilimantic, Conn.
Kelly Spear Co. ..... Bath, Maine.
Kennedy Valve Mfg. Co. ..... Elmira, N. Y.
King Sewing Machine Co. ..... Buffalo, N. Y.
Keiser & Boasberg ..... Buffalo, N. Y.
Ketterlinus Lithographic Mfg. Co. ..... Philadelphia, Pa.
Keystone Watch Case Co. ..... Riverside, N. J.
K. & B. Co. ..... Philadelphia, Pa.
Keller Mechanical Engr. Co. ..... Brooklyn, N. Y.
King & Co., J. B. ..... New York, N. Y.
Koken Barbers' Supply Co. ..... St. Louis, Mo.
Knight Machinery Co., W. B. ..... St. Louis, Mo.
King Machine Tool Co. ..... Cincinnati, Ohio.
Kirby Bonner Lumber Co. ..... Houston, Texas.
Karpen & Bros., S. ..... New York, N. Y.
Kempsmith Mfg. Co. ..... Milwaukee, Wis.
Keith Company, Geo. E. ..... Campello, Mass.
Kellogs & Miller ..... Amsterdam, N. Y.
Kellog Toasted Corn Flake Co. ..... Battle Creek, Mich.
Kissel Motor Car Co. ..... Hartford, Wis.
Kalamazoo Loose Leaf Binder Co. ..... Kalamazoo, Mich.
Knox Motors Company ..... Springfield, Mass.
Krebs Pigment & Chemical Co. ..... Newport, Del.
King Foundry Co. ..... St. Joseph, Mo.
King Paper Co. ..... Kalamazoo, Mich.
Koban Manufacturing Co. ..... Milwaukee, Wis.
Kilbourn & Jacobs Mfg. Co. ..... Columbus, Ohio.

Lacleed-Christy Clay Products Co. ..... St. Louis, Mo.
Lyon & Healy ..... Chicago, Ill.
Lamb-Fish Lumber Co. ..... Charleston, Miss.
Lexington-Howard Co. ..... Connersville, Ind.
Lane Mfg. Co. ..... Montpelier, Vt.
Leland-Gifford Co. ..... Worcester, Mass.
Lobdell Car & Wheel Co. ..... Wilmington, Del.
Liberty Motor Car Co. ..... Detroit, Mich
Lightwell Steel Sash Co. ..... Newport, Del.
Long-Bell Lumber Co. ..... Beaumont, Tex.
Luitwieler Pumping Engine Co. ..... Rochester, N. Y.
Lake Breeze Motor ..... Chicago, Ill.
Lawrence Mfg. Co. ..... Lowell, Mass.
Levi Strauss & Co. ..... San Francisco, Cal.
Lyon Metallic Mfg. Co. ..... Aurora, Ill
Lanahan & Son, Wm. ..... Baltimore, Md.
Lansing Co. ..... Lansing, Mich.
Lean Mfg. Co., Roderick ..... Mansfield, Ohio.
Lane Mfg. Co. ..... Montpelier, Vt.

Light Railway Equipment Co. ..... Philadelphia, Pa.
Lidgerwood Mfg. Co. ..... Brooklyn, N. Y.
Libby, McNeill & Libby ..... Chicago, Ill.
Lodge & Shipley Machine Tool Co. ..... Cincinnati, Ohio.
Lanston Monotype Machine Co. ..... Philadelphia, Pa.
Lehigh Car, Wheel & Axle Works ..... Catasauqua, Pa.
Lucas Machine Tool Co. ..... Cleveland, Ohio.
Lipe, W. C. ..... Syracuse, N. Y.
Louisiana Oil Refining Corp. ..... Shreveport, La.
Lackawanna Leather Co. ..... Hackettstown, N. J.
Lawrence & Co. ..... New York, N. Y.
LeRoi Co. ..... Milwaukee, Wis.
LeBlond Machine Tool Co., R. K. ..... Cincinnati, Ohio.
Lawley & Son Corp., Geo. ..... Neponset, Mass.
Lincoln Twist Drill Co. ..... Taunton, Mass.
LaBelle Iron Works ..... Steubenville, Ohio.
Lapointe Co., J. N. ..... New London, Conn.
Lauson Mfg. Co., John ..... New Holstein, Wis.
Lindsay Light Co. ..... Chicago, Ill.
Lowney Co., Walter M. ..... Boston, Mass.
Lewis-Hall Iron Works ..... Detroit, Mich.
Lees-Bradner Co. ..... Cleveland, Ohio.
LaResista Corset Co. ..... Bridgeport, Conn.
Long & Allstatter Co. ..... Hamilton, Ohio.
Lauderdale Cotton Mills ..... Meridian, Miss.
Little Falls Mfg. Co. ..... Little Falls, N. Y.
Ludowici-Celadon Co. ..... Chicago, Ill.
Lewis & Bros. Co., John T. ..... Philadelphia, Pa.
Lancaster Tire & Rubber Co. ..... Lancaster, Ohio.
Landis Tool Co. ..... Waynesboro, Pa.
Loose-Wiles Biscuit Co. ..... Kansas City, Mo.
Luckett Wake Tobacco Co. ..... Louisville, Ky.
Lester Piano Co. ..... Philadelphia, Pa.
Lee Tire & Rubber Co. ..... Conshohocken, Pa.
Luptons Sons Co., David ..... Philadelphia, Pa.
Leffel & Co., James ..... Springfield, Ohio.
Lisenby Mfg. Co. ..... Fresno, Cal.
LaCrosse Plow Co. ..... LaCrosse, Wis.
Lawrence Leather Co., A. C. ..... Boston, Mass.
Lynchburg Foundry Co. ..... Lynchburg, Va.
Luce Sugar Cane Harvester Co., Inc. ..... Watertown, Wis.
Lupton's Sons Co., David ..... Philadelphia, Pa.
Laboratory Supply Co. ..... Columbus, Ohio.
Lucey Manufacturing Corp. ..... New York, N. Y.
Liggett & Myers Tobacco Co. ..... New York, N. Y.
Likly & Co., Henry ..... Rochester, N. Y.

Modern Tool Co. ..... Erie, Pa.
Mather Spring Co. ..... Toledo, Ohio.
Mills Novelty Co. ..... Chicago, Ill.
McKay & Co., James ..... Pittsburgh, Pa.
Markham Air Rifle Co. ..... Plymouth, Mich.
Massachusetts Breweries Co. ..... Boston, Mass.

Monument Pottery Co. ..... Trenton, N. J.
Morris Machine Works ..... Baldwinsville, N. Y.
Moorhead Knitting Co., Inc. ..... Harrisburg, Pa.
McConway & Torley Co. ..... Pittsburgh, Pa.
Mt. Vernon Woodberry Mills, Inc. ..... Baltimore, Md.
Missouri Belting Co. ..... St. Louis, Mo.
Motor Products Co. ..... Ann Arbor, Mich.
Moore Drop Forging Co. ..... Springfield, Mass.
McCaskey Register Co. ..... Alliance, Ohio.
Monarch Machine Tool Co. ..... Sidney, Ohio.
Milwaukee Concrete Mixer Co. ..... Milwaukee, Wis.
Metal Specialties Mfg. Co. ..... Chicago, Ill.
Murchey Machine & Tool Co. ..... Detroit, Mich.
Myers & Bro., F. E. ..... Ashland, Ohio.
Morgan Engineering Co. ..... Alliance, Ohio.
Maxwell Motor Sales Corp. ..... Detroit, Mich.
Mianns Motor Works ..... Stamford, Conn.
Mishawaka Woolen Mfg. Co. ..... Mishawaka, Ind.
Mayer Bros. Co. ..... Mankato, Minn.
Mohawk Rubber Co. ..... Akron, Ohio
Marion Steam Shovel Co. ..... Marion, Ohio.
Marine Compass Co. ..... Bryantville, Mass.
Mummert-Dixon Co. ..... Hanover, Pa.
Mathew Gravity Carrier Co. ..... Ellwood City, Pa.
Marietta Rug Extractor Co. ..... Marietta, Ohio.
Milholland Machine Co. ..... Indianapolis, Ind.
Milholland Co., J. & J. B. ..... Pittsburgh, Pa.
McIntosh & Seymour Corp. ..... Auburn, N. Y.
Metallic Drawing Roll Co. ..... Indian Orchard, Mass.
Mason Machine Works ..... Taunton, Mass.
Menner Chemical Co., G. ..... Newark, N. J.
MacAndrews & Forbes Co. ..... Camden, N. J.
Miner Hillard Milling Co. ..... Wilkes Barre, Pa.
Manhattan Rubber Mfg. Co. ..... New York, N. Y.
Mark Manufacturing Co. ..... Chicago, Ill.
Matlack Coal & Iron Corp. ..... New York, N. Y.
McCord Manufacturing Co., Inc. ..... Detroit, Mich.
Massachusetts Saw Works ..... Springfield, Mass.
Morse Chain Co. ..... Ithaca, N. Y.
Miller, DuBrul & Peters Mfg. Co. ..... Cincinnati, Ohio.
Mackintosh, Hemphill & Co. ..... Pittsburgh, Pa.
Mesta Machine Company ..... Pittsburgh, Pa.
Marvin & Casler Co. ..... Canastota, N. Y.
Mechanical Appliance Co. ..... Milwaukee, Wis.
Maddock's Sons Co., Thomas ..... Trenton, N. J.
Moyer, Walter W. ..... Ephrata, Pa.
Macomber & Whyte Rope Co. ..... Kenosha, Wis.
Martel Manufacturing Co. ..... New York, N. Y.
Morris Machine Tool Co. ..... Cincinnati, Ohio.
Merrimack Mfg. Co. ..... Lowell, Mass.
McDougall Paint Co., Inc. ..... Buffalo, N. Y.
Matthews & Co., C. J. ..... Philadelphia, Pa.
Mentholatum Co. ..... Buffalo, N. Y.

Mundt & Sons, Charles.....Jersey City, N. J.
Manhattan Rubber Mfg. Co.....Passaic, N. J.
Myers Manufacturing Co.....Camden, N. J.
Mercer Automobile Co.....Trenton, N. J.
Majestic Co.....Huntington, Ind.
Milton Manufacturing Co.....Milton, Pa.
McFell Signal Co.....Chicago, Ill.
Meeky Co., A.....Philadelphia, Pa.
Myers-Whaley Co., Inc.....Knoxville, Tenn.
McElwain Co., W. H.....Boston, Mass.
Mersereau Metal Bed Co.....Jersey City, N. J.
Malleable Iron Fittings Co.....Branford, Conn.
Mecklenburg Iron Works.....Charlotte, N. C.
Murphy Varnish Co.....Newark, N. J.
Motor Compressor Co.....Newark, N. J.
Modern Machinery Co.....Wilmington, Del.
Martell Packings Co.....Elyria, Ohio.
Morgan Co.....Oshkosh, Wis.
Morse Aircraft Corp., Thomas.....Ithaca, N. Y.
Mitchell Motors Co., Inc.....Racine, Wis
Mitts & Merrill.....Saginaw, Mich.
Modern Engineering Co.....St. Louis, Mo.
Murray Co.....Atlanta, Ga.
Myers Co., Thomas J.....Baltimore, Md.
Mine & Smelter Supply Co.....New York, N. Y.
Monongahela Tube Co.....Pittsburgh, Pa.
Mason Regulator Co.....Boston, Mass.

New Departure Mfg. Co.....Bristol, Conn.
New England Enameling Co., Inc.....New York, N. Y.
Norton Company.....Worcester, Mass.
National Malleable Castings Co.....Cleveland, Ohio.
Norton Grinding Co.....Worcester, Mass.
Noble & Co., F. H.....Chicago, Ill.
National Scale Co.....Chicopee Falls, Mass.
Nordberg Mfg. Co.....Milwaukee, Wis.
Northern Engineering Works.....Detroit, Mich.
National Ammonia Co.....St. Louis, Mo.
New Jersey Wire Cloth Co.....Trenton, N. J.
National Electric Signaling Co.....Brooklyn, N. Y.
North Packing & Provision Co.....Somerville, Mass.
Novo Engine Co.....Lansing, Mich.
Napier Saw Works, Inc.....Springfield, Mass.
Niles Bement Pond Co.....Plainfield, N. J.
New Castle Leather Co.....New York, N. Y.
Newport Rolling Mill Co.....Newport, Ky.
Nash, Inc., Dane H.....Millington, N. J.
Nugent & Co., Wm. W.....Chicago, Ill.
Northern Equipment Co.....Erie, Pa.
Noyes Machine Co.....South Portland, Maine.
National Radiator Co.....Johnstown, Pa
Notaseme Hosiery Co.....Philadelphia, Pa.
National Marking Machine Co.....Cincinnati, Ohio.

North Wayne Tool Co. ..... Hallowell, Maine.
National Acme Co. ..... Cleveland, Ohio.
New Process Gear Corp. ..... Syracuse, N. Y.
Nagel & Co., W. R. ..... Paducah, Ky.
National Alloy Co. ..... Philadelphia, Pa.
National Equipment Co. ..... Springfield, Mass.
National Brake Co. ..... Buffalo, N. Y.
National Metal Molding Co. ..... Pittsburgh, Pa.
North Bros. Mfg. Co. ..... Philadelphia, Pa.
New Britain Machine Co. ..... New Britain, Conn.
National Cash Register Co. ..... Dayton, Ohio.
National Automatic Tool Co. ..... Richmond, Ind.
Ney Company, J. M. ..... Hartford, Conn.
National Supply Co. ..... Pittsburgh, Pa.
National Brake & Electric Co. ..... Milwaukee, Wis.
Northwestern Terra Cotta Co. ..... Chicago, Ill.
Newton Falls Mfg. Co. ..... Newton Falls, Ohio.
Northwestern Chemical Co. ..... Marietta, Ohio.
Nelson Valve Co. ..... Philadelphia, Pa.
National Tool Co. ..... Cleveland, Ohio.
New Way Motor Co. ..... Lansing, Mich.
New York Engineering Co. ..... New York, N. Y.
North Bangor Slate Co. ..... Bangor, Maine.
New Jersey Zinc Co. ..... New York, N. Y.

Oat & Sons, Joseph ..... Philadelphia, Pa.
Otis Elevator Co. ..... New York, N. Y.
Ott Grinder Co. ..... Indianapolis, Ind.
Oliver Machinery Co. ..... Grand Rapids, Mich.
O'Neill Machine Co. ..... Toledo, Ohio.
Oliver Mfg. Co., W. W. ..... Buffalo, N. Y.
Osia Ouken Co. ..... Cincinnati, Ohio.
Orona Manufacturing Co. ..... Boston, Mass.
O. K. Mfg. Co. ..... Syracuse, N. Y.
Otis Steel Co. ..... Cleveland, Ohio.
Owens Co., J. L. ..... Minneapolis, Minn.
Oliver Chilled Plow Works ..... South Bend, Ind.
Ohio Suspender Co. ..... Mansfield, Ohio.

Pittsburgh Plate Glass Co. ..... Pittsburgh, Pa.
Pairpoint Corporation ..... New Bedford, Mass.
Pike Manufacturing Co. ..... Pike, N. H.
Pelzer Mfg. Co. ..... Pelzer, S. C.
Pittsburgh Steel Products Co. ..... Pittsburgh, Pa.
Plumb, Inc., Fayette R. ..... Philadelphia, Pa.
Pittsburgh Filter Mfg. Co. ..... Pittsburgh, Pa.
Postum Cereal Co. ..... Battle Creek, Mich.
Pacific Lumber Co. ..... San Francisco, Cal.
Palmer Co., I. E. ..... Middletown, Conn.
Pacific Creosoting Co. ..... Seattle, Wash.
Parlin & Orendorff Co. ..... Canton, Ill.
Perkins & McNeely ..... Philadelphia, Pa.
Pratt Food Co. ..... Philadelphia, Pa.

Prouty & Co., Inc., Isaac.....Spencer, Mass.
Pennsylvania Optical Co.....Reading Pa.
Pittsburgh Iron & Steel Foundries Co.....Midland, Pa.
Pennsylvania Engineering Works.....New Castle, Pa.
Pittsburgh Electric Specialties Co.....New York, N. Y.
Paiste Co., H. T.....Philadelphia, Pa.
Pabst Brewing Co.....Milwaukee, Wis.
Packard Co., M. A.....Brockton, Mass.
Philadelphia Quartz Co.....Philadelphia, Pa.
Penn Tobacco Co.....Wilkes Barre, Pa.
Pawtucket Mfg. Co.....Pawtucket, R. I.
Pilling & Crane.....Philadelphia, Pa.
Penn Engineering Co.....Philadelphia, Pa.
Parkesburg Iron Co.....Parkesburg, Pa.
Powell Machine Co.....Worcester, Mass.
Pittsburgh Crushed Steel Co.....Pittsburgh, Pa.
Port Huron E. & T. Co.....Port Huron, Mich.
Pressed Prism Plate Glass Co.....Morgantown, W. Va.
Pierce Machine Tool Co.....Chicago, Ill.
Pennsylvania Wire Glass Co.....Philadelphia, Pa.
Patton Paint Co.....Newark, N. J.
Plumpton Press.....Norwood, Mass.
Parker Pen Co.....Janesville, Wis.
Pratt & Whitney Co.....Hartford, Conn
Pittsburgh Sheet & Tin Plate Co.....Pittsburgh, Pa.
Parish Manufacturing Co.....Reading, Pa.
Plymouth Cordage Co.....N. Plymouth, Mass.
Phillips Pressed Steel Pulley Works.....Philadelphia, Pa.
Paper Manufacturer's Co.....Philadelphia, Pa.
Paxson Co., J. W.....Philadelphia, Pa.
Persons-Arter Machine Co.....Worcester, Mass.
Puritan Soap Co.....Rochester, N. Y.
Pavania Oil Co.....Warren, Pa.
Pittsburgh Screw & Bolt Co.....Pittsburgh, Pa.
Pittsburgh Forge & Iron Co.....Pittsburgh, Pa.
Parish & Bingham Co.....Cleveland, Ohio.
Pittsburgh Pneumatic Co.....Canton, Ohio.
Pecora Paint Co.....Philadelphia, Pa.
Pierce Co., Wm. B.....Buffalo, N. Y.
Porter H. K.....Everett, Mass.
Patch, A. H.....Clarksville, Tenn.
Parsons Co.....Newton, Iowa.
Phillips & Buttorff Mfg. Co.....Nashville, Tenn.
Piqua Handle & Mfg. Co.....Piqua, Ohio.
Pyrolin Co.....Fort Dodge, Iowa.
Pennsylvania Sugar Co.....Philadelphia, Pa.
Pratt Chuck Co.....Frankfort, N. Y.
Pickering Governor Co.....Portland, Conn.
Pitman Co., Geo. W.....Denison, Texas.
Porter, Co., H. K.....Pittsburgh, Pa.
Plant Co., Thomas G.....Boston, Mass.
Peck, Stow & Wilcox Co.....New York, N. Y.
Paige-Detroit Motor Car Co.....Detroit, Mich.

Pittsburgh Steel Co. ..... Pittsburgh, Pa.
Penberthy Injector Co. ..... Detroit, Mich.
Pittsburgh Valve, Foundry & Const. Co. ..... Pittsburgh, Pa.
Pilling Brass Co. ..... Waterbury, Conn.
Pittsburgh-Des Moines Steel Co. ..... Pittsburgh, Pa.
Pawling & Harnischfeger Co. ..... Milwaukee, Wis.
Primos Chemical Co. ..... Primos, Pa.
Page Needle Co. ..... Chicopee Falls, Mass.
Peerless Tube Co. ..... Bloomfield, N. J.
Proudfit Loose Leaf Co. ..... Grand Rapids, Mich.
Pioneer Corporation ..... Chicago, Ill.
Progressive Shoe Machinery Co. ..... Minneapolis, Minn.
Paris Medicine Co. ..... St. Louis, Mo.
Precision Instrument Company ..... Detroit, Mich.
Powers Mining Machine Co. ..... Cudahy, Wis.

Quaker City Chocolate & Confectionery Co. ..... Philadelphia, Pa.
Quaker City Iron Works ..... Philadelphia, Pa.

Royersford Foundry & Machine Co., Inc. ..... Philadelphia, Pa.
Rome Manufacturing Co. ..... Rome, N. Y.
Root Co., A. I. ..... Medina, Ohio.
Reed & Prince Mfg. Co. ..... Worcester, Mass.
Reynolds Tobacco Co., R. J. ..... Winston-Salem, N. C.
Raybestos Co. ..... Bridgeport, Conn.
Rockford Lathe & Drill Co. ..... Rockford, Ill.
Rice & Hutchins ..... Boston, Mass.
Rochester Stamping Co. ..... Rochester, N. Y.
Rhoades & Sons, J. E. ..... Philadelphia, Pa.
Rochester Spectacle Co. ..... Rochester, N. Y.
Rossendale Reddaway Belting & Hose Co. ..... Newark, N. J.
Ritter Dental Mfg. Co. ..... Rochester, N. Y.
Ruud Manufacturing Co. ..... Pittsburgh, Pa.
Rowe Motor Mfg. Co. ..... Downingtown, Pa.
Ramapo Iron Works ..... Niagara Falls, N. Y.
Rare Metals Export Co. ..... North Chicago, Ill.
Rueping Leather Co., Fred ..... Fond du Lac, Wis.
Ridgely Trimmer Co. ..... Springfield, Ohio.
Roe Stephens Mfg. Co. ..... Detroit, Mich.
Rowe Calk Co. ..... Plantsville, Conn.
Reading Standard Co. ..... Reading, Pa.
Reliance Electric & Engineering Co. ..... Cleveland, Ohio.
Rueckheim Bros. & Eckstein ..... Chicago, Ill.
Rumsey Pump Co., Ltd. ..... Seneca Falls, N. Y.
Regina Hosiery Mfg. Co. ..... Haw River, N. C.
Reeves Bros. Co. ..... Alliance, Ohio.
Reliance Gauge Column Co. ..... Cleveland, Ohio.
Reading Hardware Co. ..... Reading, Pa.
Root Co., C. J. ..... Bristol, Conn.
Rome-Turney Radiator Co. ..... Rome, N. Y.
Reed Co., Francis ..... Worcester, Mass.
Roto Co. ..... Hartford, Conn.
Ross Valve Mfg. Co. ..... Troy, N. Y.

Royal Typewriter Co., Inc. ..... New York, N. Y.
Ransome Concrete Machinery Co. ..... Dunellen, N. J.
Roebling's Sons Co., John A. ..... Trenton, N. J.
Robinson & Son Co., Wm. C. ..... Baltimore, Md.
Reid Gas Engine Co., Joseph ..... Oil City, Pa.
Reed-Prentice Co. ..... Worcester, Mass.
Rockford Drilling Machine Co. ..... Rockford, Ill.
Remington Typewriter Co. ..... New York, N. Y.
Russell Burdsall & Ward Bolt & Nut Co. ..... Port Chester, N. Y.
Roy & Son Co., B. S. ..... Worcester, Mass
Remington Machine Co. ..... Wilmington, Del.
Richardson Phenix Co. ..... Milwaukee, Wis.
Richardson Scale Co. ..... Passaic, N. J.
Reo Motor Car Co. ..... Lansing, Mich.
Raymond Bros. ..... Chicago, Ill.

Seven Shipyard ..... Dumbarton, Scotland.
Snyder, Inc., H. S. & M. W. ..... Boston, Mass.
Standard Pressed Steel Co. ..... Philadelphia, Pa.
Spalding & Bros., A. G. ..... New York, N. Y.
Sleeper & Hartley, Inc. ..... Worcester, Mass.
Sandwich Mfg. Co. ..... Sandwich, Ill.
Stutz Motor Car Co. of America, Inc. ..... Indianapolis, Ind.
Southern Pine Co. of Georgia ..... Savannah, Ga.
Sparks Withington Co. ..... Jackson, Mich.
Southern States Lumber Co. ..... Pensacola, Fla.
Stumbay Carlson Tel. Mfg. Co. ..... Rochester, N. Y.
Seneca Iron & Steel Co. ..... Buffalo, N. Y.
Stow Mfg. Co. ..... Binghamton, N. Y.
Springfield Boiler Co. ..... Springfield, Ill.
Steinle Turret Machine Co. ..... Madison, Wis.
Seattle Frog & Switch Co. ..... Seattle, Wash.
Security Insert Co. ..... Philadelphia, Pa.
Smith Engineering Co. ..... Milwaukee, Wis.
Standard Refractories Co. ..... Claysburg, Pa.
Superior Seating Co. ..... Muskegon, Mich.
Sprague Co., J. P. ..... Kansas City, Mo.
Spencer Turbine Cleaner Co. ..... Hartford, Conn.
St. Louis Machine Tool Co. ..... St. Louis, Mo.
South Porto Rico Sugar Co. ..... New York, N. Y.
Scranton Stove Works ..... Scranton, Pa.
Smokeless Fuel Co. ..... Cincinnati, Ohio.
Safety Emery Wheel Co. ..... Springfield, Ohio.
Sheldon Axle & Spring Co. ..... Wilkes Barre, Pa.
Sharpless Specialty Co. ..... West Chester, Pa.
Schramm & Son, Chris. D. ..... Philadelphia, Pa.
Sulpho-Naphthol Co. ..... Boston, Mass.
Sprague Meter Co. ..... Bridgeport, Conn.
Standard Sanitary Mfg. Co. ..... New York, N. Y.
Southern Products Co. ..... Dallas, Texas.
Steptoe Co., John ..... Cincinnati, Ohio.
Sipp Machine Co. ..... Paterson, N. J.
Simonds Mfg. Co. ..... Pittsburgh, Pa.

Schwing Lumber & Shingle Co., Ltd. ..... Plaquemine, La.
Sessions & Co., J. H. ..... Bristol, Conn.
Sangamo Electric Co. ..... Springfield, Ill.
Stowell Co. ..... So. Milwaukee, Wis.
South Bend Chilled Plow Co. ..... South Bend, Ind.
Smith, Drum & Co. ..... Philadelphia, Pa.
Sharon Steel Hoop Co. ..... Sharon, Pa.
Sheldon & Co., G. W. ..... Chicago, Ill.
Sterling Motor Truck Co. ..... Milwaukee, Wis.
Springfield Machine Tool Co. ..... Springfield, Ohio.
Standard Knitting Mills ..... Knoxville, Tenn.
Schwager Nettleton Mills ..... Seattle, Wash.
Shredded Wheat Co. ..... Niagara Falls, N. Y.
Sall Mountain Co. ..... Chicago, Ill.
Sellers & Co., Inc., Wm. ..... Philadelphia, Pa.
Scripps-Booth Corp. ..... New York, N. Y.
Speer Carbon Co. ..... St. Mary's, Pa.
Spencer Lens Co. ..... Buffalo, N. Y.
Sperry Flour Co. ..... San Francisco, Cal.
Saxon Motor Car Corp. ..... Detroit, Mich.
Slocomb & Co., Inc., F. F. ..... Wilmington, Del.
Standard Paper Mfg. Co. ..... Richmond, Va.
Simmons Co., John ..... New York, N. Y.
Shepard Electric Crane & Hoist Co. ..... Montour Falls, N. Y.
Sayre & Fisher Co. ..... Sayreville, N. J.
Sharp Spark Plug Co. ..... Cleveland, Ohio.
Standard Underground Cable Co. ..... Pittsburgh, Pa.
Skinner Engine Co. ..... Erie, Pa.
Service Motor Truck Co. ..... Wabash, Ind.
Stevens Arms Co., J. ..... Chicopee Falls, Mass.
Standard Motor Truck Co. ..... Pittsburgh, Pa.
Starrett Co., L. S. ..... Athol, Mass.
Sanderson Cyclone Drill Co. ..... Orrville, Ohio.
Steel City Electric Co. ..... Pittsburgh, Pa.
Scott Paper Co. ..... Philadelphia, Pa.
Seamans & Cobb Co. ..... Boston, Mass.
Stamford Mfg. Co. ..... Stamford, Conn.
Smooth-On Mfg. Co. ..... Jersey City, N. J.
Smith & Bros. Typewriter Co., L. C. ..... Syracuse, N. Y.
Stone, Timlow & Co., Inc. ..... West Medford, Mass.
Skinner Chuck Co. ..... New Britain, Conn.
Stewart Warner Speedometer Corp. ..... Chicago, Ill.
Signal Motor Truck Co. ..... Detroit, Mich.
South Bend Lathe Works ..... South Bend, Ind.
Steppocher & Bro., Inc., W. M. ..... Philadelphia, Pa.
Southern Textile Machinery Co. ..... Paducah, Ky.
Spirella Co., Inc. ..... Niagara Falls, N. Y.
Seaboard Rice Milling Co. ..... Galveston, Texas.
Standard Engineering Co. ..... Ellwood City, Pa.
Schrafft & Sons, Corp., W. F. ..... Boston, Mass.
Swaby Mfg. Co. ..... Chicago, Ill.
Standard Oil Cloth Co. ..... New York, N. Y.
Selig Polyscope Co. ..... Chicago, Ill.

Santa Cruz Portland Cement Co. ..... San Francisco, Cal.
Seneca Falls Mfg. Co. ..... Seneca Falls, N. Y.
Smith Co., T. L. ..... Milwaukee, Wis.
Standard Separator Co. ..... Milwaukee, Wis.
Schwab & Sons Co., R. J. ..... Milwaukee, Wis.
Silver Steel Casting Co. ..... Milwaukee, Wis.
Shinola Co. ..... Rochester, N. Y.
Stock Kylite Grease & Oil Co., G. B. ..... Port Huron, Mich.
Syracuse Industrial Gas Co. ..... Syracuse, N. Y.
Smith, Kline & French Co. ..... Philadelphia, Pa.
Spencer Wire Co. ..... Worcester, Mass.
Standard Woven Fabric Co. ..... Walpole, Mass.
Seydel Mfg. Co. ..... Jersey City, N. J.
Springdale Finishing Co., Inc. ..... Canton, Ohio.
Safety Wire Gas Globe Co. ..... Columbus, Ohio.
Stearns & Co., Frederick ..... Detroit, Mich.
Swinehart Tire & Rubber Co. ..... Akron, Ohio.
St. Louis Label Works ..... St. Louis, Mo.
Stover Mfg. & Engine Co. ..... Freeport, Ill.
Standard Tin Plate Co. ..... Canonsburg, Pa.
Slipper City Wood Heel Co. ..... Haverhill, Mass.
Star Mfg. Co. ..... Carpentersville, Ill.
Simplex Electric Heating Co. ..... Cambridge, Mass.
Stephens Adamson Mfg. Co. ..... Aurora, Ill.
Stewart Iron Works Co. ..... Cincinnati, Ohio.
Stehling Co., Chas. H. ..... Milwaukee, Wis.
Sibley Machine Co. ..... South Bend, Ind.
Stevenson Door Co., C. S. ..... Chester, Pa.
Snow Construction Co., T. W. ..... Chicago, Ill.
Stroud & Co., E. H. ..... Chicago, Ill.
Samson Cordage Works ..... Boston, Mass.
Sligo Iron & Steel Co. ..... Connellsville, Pa.
Sturtevant Mill Co. ..... Boston, Mass.
Standard Varnish Works ..... New York, N. Y.
Stoll Co., D. H. ..... Buffalo, N. Y.
Shantz, Inc., M. B. ..... Rochester, N. Y.
Schmidt & Ault Paper Co. ..... York, Pa.
Southern Embroidery Co. ..... Baltimore, Md.
Swift & Co. ..... Jersey City, N. J.
Sun Motor Car Co. ..... Elkhart, Ind.
Scovill Manufacturing Co. ..... Waterbury, Conn.
Stetson Shoe Co. ..... South Weymouth, Mass.
Sullivan Lumber Co., Alger ..... Century, Florida.
Star Drilling Machine Co. ..... Akron, Ohio
Standard Chemical Co. ..... Canonsburg, Pa.
Standard Alloys Co. ..... Canonsburg, Pa.
Specialty Mfg. Co. ..... St. Paul, Minn.
Stedman's Foundry & Machine Works ..... Aurora, Ind.
Simmons Machine Co., Inc. ..... Albany, N. Y.

Taylor Instrument Companies ..... Rochester, N. Y.
Taft Peirce Mfg. Co. ..... Woonsocket, R. I.
Transmission Ball Bearing Co., Inc. ..... Buffalo, N. Y.

Turner, Day & Woolworth Handle Co. ..... New York, N. Y.
Triumph Mfg. Co. ..... Cincinnati, Ohio.
Thompson Grinder Co. ..... Springfield, Ohio.
Thomas & Sons Co., R. ..... East Liverpool, Ohio.
Thompson & Co., James ..... New York, N. Y.
Thew Automatic Shovel Co. ..... Lorain, Ohio.
Todd Protectograph Co. ..... Rochester, N. Y.
Torris Wold & Co. ..... Chicago, Ill.
Troy Engine & Machine Co. ..... Troy, Pa.
Tropical Paint & Oil Co. ..... Cleveland, Ohio.
Tanners Extract Co. ..... Charleston, W. Va.
Tuthill Spring Co. ..... Chicago, Ill.
Terrell's Equipment Co. ..... Michigan, Mich.
Temperton Kenly & Co. ..... Chicago, Ill.
Thompson Type Machine Co. ..... Chicago, Ill.
Thum Co., O. & W. ..... Grand Rapids, Mich.
Taylor & Co., Inc., N. G. ..... Philadelphia, Pa.
Townsend & Co., E. M. ..... New York, N. Y.
Turner & Seymour Mfg. Co. ..... Torrington, Conn.
Tyer Rubber Co. ..... Andover, Mass.
Taylor Wilson Mfg. Co. ..... McKees Rocks, Pa.
Treadwell Engineering Co. ..... Easton, Pa.
Thomson Machine Co. ..... Belleville, N. J.
Torner Co., A. J. ..... Boston, Mass.
Taylor Co., Inc., J. P. ..... Richmond, Va.
Texas Co. ..... New York, N. Y.
Taylor-Wharton Iron & Steel Co. ..... High Bridge, N. J.
Troy Laundry Machinery Co., Ltd ..... New York, N. Y.
Trump Bros. Machine Co. ..... Wilmington, Del.
Tucker, W. W. & C. F. ..... Hartford, Conn.
Taunton-New Bedford Copper Co. ..... New Bedford, Mass.
Tuck & Co., G. O. ..... Louisville, Ky.
Treman, King & Co. ..... Ithaca, N. Y.

Upson Co. ..... Lockport, N. Y.
Upson Nut Co. ..... New York, N. Y.
United States Glass Co. ..... Pittsburgh, Pa.
Union Foundry Works ..... Chicago, Ill.
United Shoe Machinery Co. ..... Boston, Mass.
Union Electric Co. ..... Trenton, N. J.
Union Special Machine Co. ..... Chicago, Ill.
United Engineering & Foundry Co. ..... Pittsburgh, Pa.
Universal Bottle Washer Co. ..... Detroit, Mich.
U. S. Radiator Corp. ..... Detroit, Mich.
United States Window Glass Co. ..... Morgantown, W. Va.
United States Glue Co. ..... Milwaukee, Wis.
Uniform Dyeing Machine Co. ..... Groveville, N. J.
Union Switch & Signal Co. ..... Swissvale, Pa.
Universal Boring Machine Co. ..... Hudson, Mass.
Union Casene Co. ..... Philadelphia, Pa.
Union Electric Co. ..... Pittsburgh, Pa.
United States Smelting Co. ..... Boston, Mass.
United Piece Dye Works ..... Lodi, N. J.

United Refining Co. ..... Warren, Pa.
United States Stamping Co. ..... Moundsville, W. Va.
U. S. Gutta Percha Paint Co. ..... Providence, R. I.
United States Envelope Co. ..... Worcester, Mass.
United Lace & Braid Mfg. Co. ..... Providence, R. I.
Universal Grinsing Machine Co. ..... Fitchburg, Mass.
Union Bag & Paper Corp. ..... New York, N. Y.
United Filters Corp. ..... Salt Lake City, Utah.
United Vacuum Appliance Co. ..... Connersville, Ind.
Union Oil Company of California ..... Los Angeles, Cal.
Universal Crusher Co. ..... Cedar Rapids, Iowa.

Vilter Mfg. Co. ..... Milwaukee, Wis.
Vulcan Last Co. ..... Portsmouth, Ohio.
Vermont Farm Machinery Co. ..... Bellows Falls, Vt.
Vim Motor Truck Co. ..... Philadelphia, Pa.
Voght Machine Co., Hy. ..... Louisville, Ky.
Victor Animatograph Co. ..... Davenport, Iowa.
Van Sicklen Co. ..... Elgin, Ill.
Van Blerck Motor Co. ..... Monroe, Mich.
Valley Iron Works Co. ..... Appleton, Wis.
Vaughan & Bushnell Mfg. Co. ..... Chicago, Ill.
Venoble Tobacco Co. ..... Durham, N. C.
Vitrified Wheel Co. ..... Westfield, Mass.
Vacuo-Static Carbon Co. ..... Rochester, N. Y.
Victor Sporting Goods Co. ..... Springfield, Mass.
Valley Paper Co. ..... Holyoke, Mass.
Victor Balata & Textile Belting Co. ..... Easton, Pa.
Ventnor Boat Works ..... Atlantic City, N. J.

Wood Iron & Steel Co., Alan ..... Philadelphia, Pa.
Webster & Co., Warren ..... Camden, N. J.
Wood's Sons Co., T. B. ..... Chambersburg, Pa.
Will & Baumer Co. ..... Syracuse, N. Y.
Western Tool & Mfg. Co. ..... Springfield, Ohio.
West Leechburg Steel Co. ..... Pittsburgh, Pa.
Whitaker-Glessner Co. ..... Wheeling, W. Va.
Wadsworth, Howland, & Co. ..... Malden, Mass.
Whittemore Bros. Corp. ..... Cambridge, Mass.
Weed Co., Inc., Lewis M. ..... Binghamton, N. Y.
Woodward & Powell Planer Co. ..... Worcester, Mass.
Wichita Falls Window Glass Co. ..... Wichita Falls, Texas.
West Virginia Timber Co. ..... Charleston, W. Va.
White Shoe Co., E. E. ..... Bridgewater, Mass.
Wilbur & Sons, Inc., H. O. ..... Philadelphia, Pa.
Western Electric Co., Inc. ..... New York, N. Y.
Wood & Brooks Co. ..... Buffalo, N. Y.
Welded Steel Barrel Corp. ..... Detroit, Mich.
Winona Wagon Co. ..... Winona, Minn.
Weston Electrical Instrument Co. ..... Newark, N. J.
Wyeth Hardware & Mfg. Co. ..... St. Joseph, Mo.
Winkler & Son, Co., Isaac ..... Cincinnati, Ohio
Wheeler-Schabler Carburetor Co. ..... Indianapolis, Ind.

Willingham & Co., Inc., W. A. ..... Danville, Va.
Wisconsin Electric Co. ..... Racine, Wis.
Windle, J. E. ..... Worcester, Mass.
Willard Storage Battery Co. ..... Cleveland, Ohio.
Wood Shovel & Tool Co. ..... Piqua, Ohio.
Wood M. & R. M. Co., Walter A. ..... Hoosick Falls, N. Y.
Winsted Hosiery Co. ..... Winsted, Conn.
Weis Mfg. Co. ..... Monroe, Mich.
Wellman-Seaver-Morgan Co. ..... Cleveland, Ohio.
Wilmot Engineering Co. ..... Hazelton, Pa.
West Boylston Mfg. Co. ..... Easthampton, Mass.
White & Wyckoff Mfg. Co. ..... Holyoke, Mass.
Wilcox & White Co. ..... Meriden, Conn.
Winchester Optical Co. ..... Horseheads, N. Y.
Wellington Machine Co. ..... Wellington, Ohio.
Warren Featherbone Co. ..... Three Oaks, Mich.
Wheland Co. ..... Chattanooga, Tenn.
Worcester Manufacturing Co. ..... Worcester, Mass.
Winchell & Co., Inc., J. H. ..... Haverhill, Mass.
Wickwire Bros., Inc. ..... Cortland, N. Y.
Wallace Supplies Mfg. Co. ..... Chicago, Ill.
Witherby Steel Co. ..... Pittsburgh, Pa.
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